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USSR AND EASTERN EUROPE SCIENTIFIC ABSTRACTS

PHYSICS AND MATHEMATICS

No. 39

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USSR

ACOUSTO-OPTICAL MODULATION ACCOMPANYING PERIODIC DEFORMATION OF A LIQUID-CRYSTAL LAYER

KOROLEV, YU. N. and YAKOVENKO, G. N., Acoustics Institute, USSR Academy of
Sciences

[Abstract] Acoustic vibrations are known to deform the uniaxial structure of
a nematic liquid crystal and thus alter its optical properties, inasmuch as
the degree of optical anisotropy is high and the viscosity is low. This
deformation thus reorients the optical axis so that birefringence and inter-
ference effects occur which can be utilized for modulation of a light beam
passing through such a layer. An experimental study was made of the dynamics
of this process. Modulation of the light beam was effected by periodic
deformation of the uniaxial crystal structure due to harmonic vibrations of
its substrate. A polarization microscope served as the basic test apparatus.
The characteristic curves of relative light intensity versus vibration
amplitude, at various frequencies and in various modes, indicate that both
a homogeneous and a homeotropic liquid-crystal cell (a 110 µm thick layer
in this experiment) will act as an acousto-optical converter and modulate
light simultaneously at the excitation frequency and its multiples. Figures
5; references 7: 4 Russian, 3 Western.

USSR   UDC 534.222.2

ACOUSTO-OPTICAL PHENOMENA IN A LIQUID CONTAINING GAS BUBBLES

YEGEREV, S. V. and NAUGOL'NYKH, K. A., Acoustics Institute, USSR Academy of
Sciences

[Abstract] An intensive laser beam impinging on a substance generates acoustic
waves in the latter. At intermediate light intensity levels the radiation of
sound is mainly due to expansion of the volume of substance where energy has
been dissipated. This mechanism is analyzed here in the case of a translucent
liquid with a plane surface with normal incidence of a light beam, the diameter
of this light beam being so much larger than the length of its path through the
medium that the resulting acoustic wave may be regarded as plane. The light is
assumed to propagate in pulses. The effect of gas bubbles contained in the
liquid on the sound intensity depends essentially on their size and their
concentration. Accordingly, the amplitude of acoustic pressure is calculated
here as a function of the bubble concentration and of the ratio of bubble

pulsation period to laser pulse width. The problem of cavitation within the focal region of laser radiation is analyzed in terms of the pressure-time profiles in a radiated acoustic pulse and in an expansion wave. Figures 3; references 3: 2 Russian, 1 Western.

CURRENT-VOLTAGE CHARACTERISTICS IN MANY-VALLEY SEMICONDUCTORS WITH AMBIGUOUS
VARIATION OF CURRENT WITH ELECTRIC FIELD

MITIN, V. V., Institute of Semiconductors, Acad. Sci. Uk SSR, Kiev

[Abstract] A study is made of many-valley semiconductors at low temperatures
with heterogeneous distribution of states and their corresponding current-
voltage curves (CVC). The actual CVC are produced for the case when as a
weak heating current flows in a classically strong transverse magnetic field
for homogeneous distribution the CVC should be of S-type, resulting from the
sharp variation in time of scattering between valleys with heating power. It
is shown that in n-Ge when the heating current is parallel to [110], and the
magnetic field is parallel to [1$\bar{1}$0], the actual CVC are generally single-
valued with great positive differential conductivity in a narrow electric
field interval, resulting from the fact that a strong current domain develops
on one of the surfaces parallel to the current and magnetic field, the current
increases with increasing field strength due to rapid movement toward the
opposite surface of the domain wall separating it from the weak current domain.
In n-Si with a heating current parallel to [100] the same CVC arises if the
rate of scattering between valleys is slow on the surface where the strong
current domain develops. If the rate is not slow, the current, fixed in a
certain interval, can be realized only with high negative differential
conductivity with the current domain moving in the direction perpendicular
to the current and magnetic field, which should lead to oscillations at a
frequency inversely proportional to the magnetic field strength. The author
thanks Z. S. Gribnikov for valuable suggestions, V. A. Kochelap for useful
discussions and O. G. Sarbey for turning the author's attention to the
peculiarities of CVC in an earlier work. Figures 2; references 12:
10 Russian, 2 Western.

EXPERIMENTAL STUDY OF PHOTOSENSITIVITY OF VARIBAND STRUCTURES

VUL', A. YA., VUL', S. P., LEZHEYKOV, L. V., LYUBOPYTOVA, YE. V., KUZNETSOV,
O. N., SAYDASHEV, I. I., SHARONOVA, L. V., SHIK, A. YA. and SHMARTSEV, YU. V.,
Institute of Physics and Technology imeni A. F. Ioffe, Acad. Sci. USSR,
Leningrad; Institute of Semiconductor Physics, Siberian Affiliate, Acad.
Sci. USSR, Novosibirsk

[Abstract] The sensitivity of photodiodes can be increased, and the spectral
range of sensitivity expanded in the direction of shorter wave lengths if the
p or n area of the photodiode is a variband layer, the width of the forbidden
band increasing smoothly from the p-n junction to the illuminated surface.
The reasons for these peculiarities of the variband are explained. This work
then presents an experimental study of the spectral variation of the photo-
sensitivity of structures with a variband layer of a solid solution of
$Al_xGa_{1-x}As$. All measurements were performed at room temperature. Specimens
of 2 types were studied: produced by liquid epitaxial growth on substrates
of p-GaAs; and produced by ion-injection synthesis. In the first type of
structure, the area of photosensitivity indicates that $L^* \approx d$, producing a
"window effect." In the second type of structure, the influence of the
stretching field of the variband structure is significant, the range of
photosensitivity is not limited to the energy area corresponding to the
"window effect," and significant photosensitivity is observed at proton
energies of over 1.7 eV. Figures 3; references 9: 5 Russian, 4 Western.

AMPLIFICATION ACROSS A p-n JUNCTION WITH HOT CHARGE CARRIERS IN SILICON

VEYNGER, A. I. and KOCHARYAN, A. A., Institute of Physics and Technology
imeni A. F. Ioffe, Acad. Sci. USSR, Leningrad

[Abstract] Experiments were performed using p-n junctions manufactured by
diffusion of boron and aluminum into the n-type silicon base material with
$p \approx 15$ ohm·cm and subsequent baking of Ni to create ohmic contacts. The
diffusion time was selected so that the depth of the p-n junction was
approximately 20 μm. The experiments indicated that the amplification
effect, as was expected, exists in silicon, although it has certain
peculiarities in this material, determined by the specifics of silicon
itself. The existence of an amplification effect in silicon makes it
promising for practical applications. Figures 2; references 3: 2 Russian,
1 Western.

A HIGH SPEED LIGHT-EMITTING DIODE OF GALLIUM PHOSPHIDE WITH GREEN LUMINESCENCE

IL'IN, YU. L., IVANOV, V. S., KOLESOV, K. M., KON'KOV, V. V., KRYUKOVA, I. V.,
and TARASOV, V. M., Leningrad Institute of Electric Engineering imeni V. I.
Ul'yanov (Lenin)

[Abstract] This work describes an LED of gallium phosphide with bright green
luminescence and a speed 1.5-2.0 orders of magnitude higher than devices made
with Zn. This is achieved by replacement of the Zn dopant with Mg in the
manufacture of the p-n junction.

Diodes were studied, the p-n junction in which was made by diffusion (with
Zn) or by epitaxial (Mg) technology. The replacement of the acceptor dopant
of zinc with magnesium, while greatly increasing the speed, does not sig-
nificantly change the brightness of the diode. The basic parameters and
characteristics of the Mg-doped LED are presented. Figures 4; references 11:
9 Russian, 2 Western.

DETERMINATION OF THE ULTIMATE THRESHOLD OF A SEMICONDUCTOR PHOTODETECTOR

DRUGOVA, A. A. and KUZNETSOVA, YE. M.

[Abstract] A calculation of the ultimate possible threshold of a semiconductor
photodetector is presented, considering the noise related to the process of
photoexcitation at short measurement times. Noise related to photoelectron
transfer is not considered. It is assumed that the noise related to background
fluctuations is significantly less, which is possible, for example, in space
applications. References 3 Russian.

ANOMALOUS EXTRINSIC PHOTOCONDUCTIVITY OF GERMANIUM DOPED WITH MERCURY AT ROOM
TEMPERATURE

GODIK, E. E., KYZNETSOV, A. I., LAZAREV, V. V. and SINIS, V. P., Institute of
Radio Technology and Electronics, Acad. Sci. USSR, Moscow

[Abstract] The advent of powerful pulsed CO_2 lasers has created a demand for
high speed uncooled radiation detectors operating at 10.6 µm. Since high
threshold sensitivity is not required, the authors studied the possibility of
increasing the operating temperature of detectors based on germanium doped with
substances with ionization energy 0.1 eV (up to room temperature). The photo-
sensitivity of germanium doped with mercury, zinc, gold and silver was measured
in the 100-300 K temperature range. The possibility of extrinsic photocon-
ductivity was studied as a function of the degree of compensation of the dopant,
quantum energy and temperature. It was found that this photoconductivity is
present in mercury-doped germanium, and results from the second level of
mercury (E_V + 0.23 eV). The experimental results are used to estimate the
probability of ionization of Hg^- centers by the radiation of the CO_2 laser.
The authors thank M. I. Barnik, Yu. G. Belashov and I. M. Tarasova for
providing samples, N. G. Zhdanova, Sh. M. Kogan, T. M. Lifshits and Ya. Ye.
Pokrovskiy for discussion of the results. Figures 6, references 9: 8 Russian,
1 Western. ·

INFLUENCE OF γ-RADIATION ON THE DYNAMIC CHARACTERISTICS OF THYRISTORS

BRYLEVSKIY, V. I., RESHETIN, V. P. and SHUMAN, V. B., Institute of Physics
and Technology imeni A. F. Ioffe, Acad. Sci, USSR, Leningrad

[Abstract] Continuing the study of thyristors subjected to γ-radiation in
order to decrease switching time, investigations were performed to establish
the relationship between the dynamic characteristics of thyristors and
the electrophysical parameters of the base layers. Thyristors with cathode
area 3 mm^2 and base thickness w_p = 20-40, w_n = 100-180 µm were manufactured
and irradiated with a ^{60}Co source of γ-radiation, creating new recombination
centers in both bases. The switching time and hole lifetime were measured at
room temperature after each radiation dose. The switching time as a function
of hole lifetime was found to follow a straight line, but the slope of the
line differed for each individual specimen. The thyristor damage factor was

found to be virtually independent of the initial resistance and of the content
of oxygen and dislocation density in the initial n-type Si. The results of
this work allow calculation of the dose required to reduce the switching time
to any desired value. Figure 1, references 7: 6 Russian, 1 Western.

SOME STUDIES OF IR RADIATION FROM TRAVELING ELECTROACOUSTIC DOMAINS IN
n-TYPE GaAs

KUROVA, I. A. and ORMONT, N. N., Moscow State University

[Abstract] IR radiation arising upon movement and destruction of a traveling
electroacoustical domain in GaAs has been studied in a number of works. This
work shows the influence of generation of a "shock" ultrasonic flux on the
time of development of radiation from a traveling domain. The studies were
performed at room and liquid nitrogen temperatures on single-crystal speci-
mens and epitaxial films of GaAs with the following characteristics: $n = 2$:
$\cdot10^{15}$ cm^{-3}, $\mu = 4,500$ cm^2/V·s at $T = 300$ K; $n = 1.9\cdot10^{16}$ cm^{-3}, $\mu = 12,000$ cm^2/
V·s at $T = 77$ K. It was found that a domain consists of 2 high field areas.
It is shown that the generation of radiation is related to the arrival of the
leading edge of a high field area within the domain, formed by shock genera-
tion of ultrasonic waves on an electric field heterogeneity near the cathode,
at the boundary of an electric field heterogeneity in the specimen. However,
it is difficult at present to state which is more important for the development
of radiation – the greatest possible power of the ultrasonic flux in this
portion of the domain or some peculiarity of the spectrum related to the
"shock" nature of the initial ultrasonic flux. Figures 3; references 7:
3 Russian, 4 Western.

THE PHOTOELECTRIC CHARACTERISTICS OF PHOTOCELLS WITH A SURFACE CHANNEL

GORBAN', A. P., LITOVCHENKO, V. G., POPOV V. G. and SERBA, A. A., Institute
of Semiconductors, Acad. Sci. Uk SSR, Kiev

[Abstract] Results are presented from a study of the photoelectrical
characteristics of surface-channel dielectric-semiconductor photocells,
illustrating, in particular, their elevated sensitivity in the near ultra-
violet area of the spectrum. In order to present high recombination losses,
the photocells were made by thermal oxidation of p-type silicon at relatively
low temperatures, resulting in a very shallow depth of the induced p-n
junction, about 0.1 μm, without increasing the concentration of recombination-
active dopants in the surface zone. The device has a typical photocurrent
relaxation time of not over 30 μs, determined by the impedance of the channel
and the conductivity of the base material. Figures 2; references 12: 10
Russian, 2 Western.

ANNEALING OF DEFECTS IN INDIUM ANTIMONIDE AFTER ION BOMBARDMENT

BOGATYREV, V. A. and KACHURIN, G. A., Institute of Semiconductor Physics
Siberian Affiliate, Acad. Sci. USSR, Novosibirsk

[Abstract] A study is presented of the electric properties of defects in
indium antimonide after ion bombardment and isochronic annealing at 20-450°C.
The initial material used was p-InSb with a concentration $p_0 = 10^{12}-10^{13}$ cm^{-3}
and mobility $\mu_0 = 3,500$ $cm^2/V \cdot s$. Measurements were conducted at 77 K on
specimens measuring 5 x 5 mm bombarded with H^+, N^+, Ne^+, Si^+, Ar^+, Cr^+ ions
with an energy of 60 keV and a dose of 10^{15} cm^{-2}, as well as He^+ ions with
an energy of 300 keV in the dose interval $10^{13} - 10^{16}$ cm^{-2}, all bombardment
at room temperature. Isochronic annealing was performed in a vacuum at 50°C
intervals, the surface being covered with a protective film beginning at
300°C. The specimens were held in liquid nitrogen to measure the conduc-
tivity and Hall effect. It is shown that n layers stable up to 100-150°C
are formed only after proton bombardment at room temperature. Ion bombardment
leads to the formation of the p layers with a high concentration of holes.
Later heating to over 150°C converts the conductivity of the bombarded layers
to electron conductivity. The concentration of electrons reaches 10^{18} cm^{-3},

the effective mobility 10^4 cm^2/V·s. The n-type layers are stable up to 350°C, so that they can be used to create n-p junctions which can be heat treated. Figures 5; references 10: 2 Russian, 8 Western.

TEMPERATURE QUENCHING OF INJECTION CURRENT AND PECULIARITIES OF THE CURRENT-VOLTAGE CHARACTERISTICS OF S DIODES

BRODOVOY, V. A., PEKA, G. P. and SMOLYAR, A. N., Kiev State University imeni T. G. Shevchenko, Kiev

[Abstract] A study is made of the complex nature of dark current-voltage curves (CVC) of symmetrical S-type GaAs diodes, compensated with Cu or Cr, in a wide area of current densities and voltages. GaAs(Cu) and GaAs(Cr) specimens with indium contacts fused in a vacuum of 10^{-5} mm Hg at 320°C for 5 minutes were studied. The dark CVC were measured using a structure with a high-resistance base length of about $0.5 \cdot 10^{-1}$ cm and a contact area of $1 \cdot 10^{-2}$ cm^2. The dark resistivity at 300 K was $3 \cdot 10^5$ ohm·cm for GaAs(Cu) and $1.4 \cdot 10^8$ ohm·cm for GaAs(Cr). It is shown that after the S-shaped area, related to modulation of base resistance by the τ mechanism, there is an N-shaped area on the CVC at high current density. Comparative studies of dark CVC and N-shaped CVC are presented with internal photoexcitation of structures of GaAs(Cu). It is shown that in the latter case, a negative differential conductivity region results from temperature quenching of the photocurrent upon Joule heating of the crystal. The mechanism is suggested for generation of the N-shape of the dark CVC of structures of GaAs(Cu) and GaAs(Cr), related to temperature quenching of the injection current. At the current densities corresponding to the beginning of the N-shaped area on the dark CVC, a temperature rise from 300- to 330 K was recorded in the GaAs(Cr) crystals. It is in this temperature area that temperature quenching of the internal photocurrent is observed. Figures 5; references 6: 4 Russian, 2 Western.

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POSITIVE FEEDBACK IN WIDE BAND IR RADIATION DETECTORS

MARMUR, I. YA. and OKSMAN, YA. A.

[Abstract] Data are presented on the variation of the photoconductive response
of the FD-1, LFD-2, AL-102 and AL-107 forward-biased photodiodes and LED's
with bias and modulation frequency of the 10.6 µm laser radiation detected.
It is found that diodes with high-series resistance at 77 K generally have
higher sensitivity than their ordinary analogs. The experimental results
are explained on the basis of the concept of internal amplification resulting
from feedback between the p-n junction and the series resistance, which is
superlinear with respect to current. The specific features of high-resistance
diodes which are analyzed help to increase their quantum effectiveness by at
least an order of magnitude. Even in a clearly asymmetrical p-n junction,
when the barrier extends to significant depth into the slightly doped area,
comparatively high IR radiation detector sensitivity can be achieved due to
internal amplification. The authors thank L. M. Kogan for useful information
and for providing light diode specimens. Figures 3; references 8 Russian.

PHOTOLUMINESCENCE ON THE INTERFACE BETWEEN A DISPERSED METALLIC FILM AND GaAs

DRAZHAN, A. V., ZUYEV, V. A., KORBUTYAK, D. V., LITOVCHENKO, V. G. and
MATSAS, YE. P., Institute of Semiconductors, Acad. Sci. Uk SSR, Kiev

[Abstract] A study is presented of radiative recombination processes on the
interface between a dispersed film or metal and a semiconductor. Particular
attention is given to analysis of the mechanisms of interaction of surface
defects with the adsorbed metals. The photoluminescence spectra excited at
4.2 K by a He-Ne laser (light absorption depth about 500 nm) were measured.
Epitaxial films of n-GaAs about 3-4 µm thick grown by the method of liquid
and gas transport epitaxy on substrates of a semi-insulating material
oriented in the (100) direction were studied. The concentration of primary
charge carriers in the films reached 10^{15} cm^{-3} with a carrier mobility of
$6-7 \cdot 10^3$ cm^2/W·s. The surfaces of the epitaxial films were doped with atoms
of Au, Ag, Pt, Pd and Ni and also subjected (before doping) to argon ion
bombardment. In doped films only a change in the rate of nonradiative
surface recombination was observed. In argon-ion bombarded films, even
before doping, new bands of surface photoluminescence were observed at 1.39
and 1.34 eV, as well as a change in the rate of radiative surface

recombination under the influence of doping, the rate increasing after doping with Au and Ag as a result of the increase in the capture cross-section of the primary carriers on the metallized areas of the surface. The rate decreased after doping with the other metals, as a result of the formation of new nonradiative complexes of surface defects plus adsorbed metals. Figures 4; references 19: 16 Russian, 3 Western.

USSR

CURRENT-VOLTAGE CHARACTERISTICS OF POINT CONTACTS WITH n-n+ JUNCTION

ASHMONTAS, S. P., OLEKAS, A. P., POZHELA, YU. K. and LAPINSKAS, R. B., Institute of Semiconductor Physics, Acad. Sci. Lit SSR, Vil'nyus

[Abstract] A theoretical and experimental study is done on the current-voltage curves (CVC) of point contacts with n-n+ junction as a function of the resistivity of the n area of the silicon and the area of the point contact at $T_0 = 300$ and 78 K. To avoid heating the crystal lattice, the CVC were measured using dc pulses 1 μs in length at a pulse repetition frequency of 40 Hz. It is determined that as high current densities are transmitted through the contact, the CVC become asymmetrical due to diffusion of hot electrons and the formation of a space charge in the area around the contact. The CVC of a point contact is calculated in the approximation of a localized relation between kinetic coefficients and the external electric field intensity. It is established that the variation in drift velocity of electrons as a function of field strength significantly influences the asymmetry of the CVC of the point contact. It is shown that in the case of highly resistive n-Si, the asymmetry of the CVC results primarily from the formation of the space charge in the area around the contact. The authors thank V. Benyushene, L. Kregzhdene and V. Linde for their assistance in the preparation of specimens. Figures 6; references 20: 13 Russian, 7 Western.

PHOTOCONDUCTIVITY OF SILICON CARBIDE IN THE SHORT-WAVE REGION OF THE SPECTRUM

BALLANDOVICH, V. S. and VIOLINA, G. N., Leningrad Electric Engineering Institute imeni V. I. Ul'yanov (Lenin)

[Abstract] A study is made of certain characteristics of the surface area of α-SiC, determined by studying the photoconductivity in the area of strong natural absorption. SiC single crystals of n- and p-type were studied following various surface treatments. In the 2.9-5.0 eV quantum energy range, spectral functions of photoconductivity and photocapacitor EMF were measured. It is shown that the change in spectral dependence of photoconductivity in the short-wave region of the spectrum is determined by the contribution of surface recombination and the presence of a space charge region. The authors thank Yu. V. Fedorovich and V. D. Savel'yev for their assistance in the work. Figures 3; references 6 Russian.

REVERSIBLE RECORDING OF OPTICAL INFORMATION IN CRYSTALS OF LEAD MAGNESIO-NIOBATE

BEREZHNOY, A. A., KOROLEV, YU. G., POPOV, YU. V., PROKOF'YEV, S. V., and SIDORENKO, N. B.

[Abstract] Ferroelectric substances with a soft phase transition have distinct optoelectric characteristics. A study was made to establish whether crystals of lead magnesioniobate could be used, accordingly, for recording optical information on the basis of photoinduced birefringence. Although these crystals are cubic with an m3m point symmetry and a quadratic optoelectric effect, at electric field intensities above 8 kV/cm in the [011] direction they become rhombic with a linear dependence of the refractive index on the intensity of the applied electric field. A theoretical analysis of such a transmission system and an evaluation of experimental results indicate that these crystals are suitable for reversible recording of optical images with a large-memory apparatus. Figures 3; references 8: 7 Russian, 1 Western.

EFFECT OF SELF-FOCUSING ON THE BREAKDOWN OF GROUP A^{II}-B^{VI} SEMICONDUCTORS
UNDER LASER RADIATION

BORSHCH, A. A., BRODIN, M. S., and KRUPA, N. N., Institute of Physics,
Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] The resistance of mixed CdS_xSe_{1-x} and $Zn_xCd_{1-x}S$ single crystals
to powerful laser radiation was measured in an experiment with single-mode
Gaussian-intensity Q-switched lasers (ruby and neodymium). Both surface and
body defects were found, the former in semiconductors with the forbidden
energy gap smaller than a laser quantum and the latter in semiconductors
with the forbidden energy gap larger than twice a laser quantum. The
mechanism of electron avalanche ionization explains these results with an
overall consistency, but the only thing certain is that self-focusing of
the laser beam constitutes the first stage of body breakdown in semicon-
ductors of the A^{II}-B^{VI} group. Figures 4; tables 1; references 7: 5 Russian,
2 Western.

A FAST-RESPONSE PYROELECTRIC DETECTOR BASED ON $Ba_{0.25}Sr_{0.75}Nb_2O_6$ CRYSTALS

VORONOV, V. V., KARLOV, N. V., KUZ'MIN, G. P., KUZ'MINOV, YU. S., KURITSYN,
B. A., NIKIFOROV, S. M., OSIKO, V. V., and PROKHOROV, A. M., Physics Institute
imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The principle of a pyroelectric detector is based on a change in
the spontaneous polarization due to a change in the temperature and producing
an electric current through the load impedance, this current being proportional
to the derivative of temperature with respect to time. An experimental study
was made to establish the feasibility of a fast-response pyroelectric detector
based on an oriented single crystal of barium-strontium niobate ($0.6 \leq x \leq 0.75$).
Such crystals were grown by the Czochralski method, then annealed for 24 h, and
placed in an electric field of about 150 kV/cm at 150°C. The temperature
dependence of the spontaneous polarization and of the pyroelectric coefficient
was measured at 1 kHz and 1 MHz, the frequency dependence of the complex di-
electric permittivity and the loss tangent was measured up to 400 MHz for
two specimens of $Ba_{0.25}Sr_{0.75}Nb_2O_6$. The temperature field in the pyroactive
material and the performance of a pyroelectric detector were calculated
theoretically, assuming: internal heat transfer by conduction only, no

heat transfer to the ambient medium, thermophysical properties independent of temperature and time, no chemical or phase changes, constant mass of the material, and uniform irradiation of the receiver pad surface. On the basis of both experimental and theoretical data, a fast-response detector has been designed which combines a high volt-watt sensitivity (20 V/MW) with a small thermal lag (2 ns) and an absence of stray piezovibrations. With a linearity up to 3 MW/cm^2 and a radiation strength of up to 9 MW/cm^2, this detector is useful for analyzing the space-time characteristics of short high-power radiation pulses from CO_2- lasers. Figures 8; tables 1; references 9: 7 Russian, 2 Western.

TEMPERATURE DEPENDENCE OF OPTICAL RECORDING AND ERASING EFFECTIVENESS ON CHALCOGENIC AsSe GLASS

VLASOV, V. I., KIKINESHI, A. A., SEMAK, D. G. and CHEPUR, D. V., Uzhgorod State University

[Abstract] The temperature dependence of the maximum attainable contrast in recording and erasing of optical data on AsSe glass, one of the materials most suitable for holographic recording at the wavelength of an He-Ne laser, was studied on specimens 2-4 μm thick. The results of measurements indicate that the maximum contrast becomes lower but is reached sooner at high recording temperatures, at which also the sensitivity of the material to laser radiation decreases. Brightening with a laser beam accelerates the erasure process and causes partial erasure at any temperature above the recording temperature. The mechanisms of recording and erasing are interpreted here in terms of the low-temperature characteristics of chalcogenic vitreous semiconductors. It is suggested that the changes in the magnitude of optical parameters due to irradiation result from changes in the atomic configuration within some domains, in turn resulting from changes in the charged state of the latter. Figures 3; references 9: 5 Russian, 4 Western.

USSR

CRYSTAL FIELD IN LASER GARNETS WITH TRIVALENT RARE-EARTH IONS IN THE EXCHANGED CHARGE MODEL

BOGOMOLOVA, G. A., BUMAGINA, L. A., KAMINSKIY, A. A., and MALKIN, B. Z., Institute of Crystallography, USSR Academy of Sciences, Moscow

[Abstract] Garnets of the $C_3A_2D_3O_{12}$ composition with the rare earth TR^{3+} ions usually at C sites are extensively studied in solid state physics, inasmuch as they serve as model systems with a large range of magnetic phase transitions. In order to establish how the energy spectrum of luminescence centers in these crystals is related to the crystal structure and composition, on the basis of the exchanged charge model, the spatial structure of the lattice near a TR^{3+} ion and the dipole moments of ions at sites other than centers of symmetry are calculated here for $Yb_3Al_5O_{12}$, $Y_3Al_3O_{12}$, $Y_3Ga_3O_{12}$, and $Y_3Sc_2Al3C_{12}$. The parameters of the crystal field and the energy levels of the Yb^{3+} ion in a regular $Yb_3Al_5O_{12}$ lattice are then determined. Of ultimate interest are the local structure of garnets activated by Nd^{3+} ions and the Stark structure of $^4I_J, ^4F_{3/2}$ multiplets of the neodynium ion in laser garnets. On account of various rough approximations, the theoretically calculated results are not very accurate and do not quite agree with experimental data. Figures 3; tables 6; references 3: 8 Russian, 26 Western.

USSR   UDC 548.736

SYNTHESIS AND STRUCTURE OF $NaUO_2(PO_3)_3$ CRYSTALS

LINDE, S. A., GORBUNOVA, YU. YE., LAVROV, A. V., and KUZNETSOV, V. G., Institute of General and Organic Chemistry imeni N. S. Kurnakov, USSR Academy of Sciences Moscow

[Abstract] Crystals of $NaUO_2(PO_3)_3$ were produced by slowly heating a mixture of 85% H_3PO_4, $NaNO_3$, and $UO_2(NO_3)_2 \cdot 6H_2O$ on the molar ratio 12:3:1 to 360°C in a Teflon crucible. The resulting compound has been found to be stable up to its melting point (800°C), at which oxygen begins to partially evolve and the color is changed from yellow to green by the appearance of tetravalent uranium ions. An x-ray examination of a monoclinic single crystal has revealed a UO_2^{2+} ion, and helical polyphosphate chains with six PO_4 tetrahedra per link. Corrugated uranyl-phosphate layers are bound by these chains into a three-dimensional skeleton. The uranium atom is coordinated with five oxygen atoms, the sodium atom is coordinated with seven oxygen atoms. Figures 2; tables 5; references: 1 Russian.

SUPERLUMINESCENCE OF CdS CRYSTALS EXCITED BY X-RADIATION PULSES

PAVLOVSKAYA, N. G., TARASOV, M. D., BALAKIN, V. A., VARAVA, V. P., LOBOV, S. I.,
SURSKIY, O. K., and TSUKERMAN, V. A.

[Abstract]   Superluminescence of CdS crystals was recorded upon their exci-
tation with x-bremsstrahlung. The crystals, in the form of 1 mm thick
plates, had been irradiated with x-ray pulses of approximately 45 ns duration
and coming from a tantalum anode bombarded with 1 MeV electrons in a high-
current accelerator with an aqueous dielectric. Irradiation with a dose
ranging from 3600 to 2900 R produced a glow over a spectral band of 15 nm
half-width with λ_{max}= 528 nm at 293 K, but a stable superluminescence with
a spectral bandwidth of 0.7 nm and with λ_{max}= 506.9 nm at 170 K. Under
exposure to a dose of 1600 R, the spectral bandwidth increased to 9 nm and
λ_{max} shifted by 22 nm from 295 to 170 K. Figures 2; references: 3 Russian.

POSSIBILITY OF DIRECT TRANSFORMATION OF CHEMICAL ENERGY TO ELECTRICAL ENERGY
ON A p-n SEMICONDUCTOR JUNCTION

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Metals Industry, Moscow

[Abstract] This report is dedicated to an analysis of the physical and chemical
prerequisites for generation of charge carriers in a redox reaction across a
p-n junction, and the effectiveness of the direct transformation of chemical
energy to electrical energy which thus occurs. Charge carriers are injected
upon adsorption of donor and acceptor molecules with separation of the excess
charge carriers in the field of the p-n junction after desorption of the
neutral molecule (reaction product). The physical-chemical conditions of
this process with development of a "chemo-emf," leading to the direct trans-
formation of chemical energy to electrical energy are formulated. Certain
electrical characteristics of the hypothetical chemical energy transformer
are estimated. The direction of the "chemo-emf" corresponds to the direction
of the forward bias of the p-n junction. References 9 Russian.

EFFECTIVENESS OF CO_2-AMPLIFIERS

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[Abstract] An important factor in laser-driven fusion are the parameters of
CO_2-amplifiers. A computer-aided optimization of pulse shaping and amplifica-
tion was undertaken for the $10^{-9}-2 \cdot 10^{-8}$ s·at range of pulse widths. For
pulses of 10^{-9} s·at and less the conversion of electric energy to coherent
radiation is most efficient (5-8%) in a discharge with the density of ab-
sorbed energy within 0.03-0.1 J/(cm^3·atm), for a pulse width equal to
$2 \cdot 10^{-8}$ s·at the conversion efficiency is 10-20% at an energy density within
0.04-0.2 J/(cm^3·atm). Of various CO_2+N_2 (and CO_2+N_2+He) mixtures tried,
$CO_2:N_2 = 1:0.25$ is found to be most effective with an electron concentration
in the discharge equal to $8 \cdot 10^{12}$ $cm^{-3} \cdot atm^{-1}$ and an electric field intensity
equal to 4-9 kV/(cm·atm). This requires special low-resistance high-voltage
energy storing devices. The discharge impedance, the amplifier gain, and
the parameter Z= K/(ηQP) (K - gain, η- efficiency, Q - energy density,
P - pressure) are independent of the radiated energy and of the pressure
in the active medium, within the given range of operation, so that the
results of this study can be used for practical design purposes. Figures 3;
tables 2; references 8: 7 Russian, 1 Western.

NONLINEAR ZEEMAN EFFECT IN A GAS RING LASER

SOKOLOV, V. A. and FRADKIN, E. YA.

[Abstract] A study is made of the influence of Bennett peaks, Herz and
optical coherence, "orientation" and "structuring" of atoms at excited levels
and modulation of populations on the difference in frequencies of oppositely
directed waves of orthogonal circular polarization in a gas ring laser. Two
cases are studied, when the active medium consists of atoms of one type, and
of two types with equal concentrations. It is shown that the nonlinear Zeeman
effect depends essentially on isotropic collisions and capture of resonant
radiation. Consideration of these interactions can explain the variation in
Zeeman splitting of lasing frequencies in He-Ne ring lasers with detuning
relative to the center line of amplification with various He and Ne pressures.
The authors thank S. S. Skulachenko and I. I. Yudin for discussing the results
and providing experimental data published earlier. Figures 3; references 19:
16 Russian, 3 Western.

INTERFEROMETRIC METHOD OF ADJUSTMENT OF THE OUTPUT CHARACTERISTICS OF GAS
LASERS

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[Abstract] A new method is suggested for adjustment of the characteristics
of the light field of gas lasers, allowing significant changes in the diver-
gence of radiated beams and production of practically identical energy dis-
tribution in the distant zone of the adjusted beam regardless of the trans-
verse mode index, its configuration and degree of spatial coherence between
mode spots. The essence of the method is that the output radiation of the
laser is transmitted through an interferometer at the output of which, with
precise transverse matching of the interfering beams, an interference field
is produced, the distribution of phases in which is determined by the differ-
ence in path length between the beams and is thus independent of the con-
figuration of the laser beam leading edge. This distribution of phase in
the interference field is easy to adjust by methods of coherent optics.
The authors thank N. V. Medved' for help in development of the optical
system and conduct of the experiments involving adjustment of the angular
characteristics of light fields in fiber optics systems. Figures 2;
references 2 Russian.

DESTRUCTION OF METAL FOILS BY LASER PULSES WHEN A PLASMA CLOUD IS PRESENT

KONONENKO, V. G. and YEMETS, A. K., Khar'kov State University

[Abstract]   Two series of experiments were performed: the first used copper
as a target, a ruby laser with λ = 6940 A as the radiation source and produced
a plasma temperature $8 \cdot 10^3$ K in front of the target of foil µm thick; the
second series used silver foil 60 µm thick as a target, and the other experi-
mental conditions were the same. It was found that in the case of copper,
when a plasma cloud was formed in front of the foil, is effectively transmitted
laser energy to the foil by reradiation at a shorter wave length than the
laser radiation, where the reflection factor of the foil was lower and,
consequently, a greater fraction of the laser energy was absorbed by the
foil. When this cloud was formed, the copper foil was not merely melted
on the surface, but penetrated. The authors thank Ya. Ye. Geguzin for de-
tailed discussion of the results of the work. Figures 2; references 3 Russian.

DESIGN OF LASERS ON THE BASIS OF SUMMARIZATION OF EXPERIMENTAL DATA

GUBA, B. S., OBRAZTSOV, G. V., PRILEZHAYEV, D. S. and SEDOV, B. M.

[Abstract] The design of lasers by reliable and simple methods is a very
important task. In most cases, purely energetic calculation is of interest,
in which changes in the time and spectral characteristics of pulses in the
process of amplification can be ignored. Generally, this problem can be
solved by the equation

$$\int_{W_o}^{W} f(W')dW' = k\ell$$

where W_0 and W are the energy densities of the radiation amplified at the
input and output of the amplifier; 1 is the length of the device; k is the
linear gain factor (i.e., the gain as $W_0 \rightarrow 0$), related to the specific
excitation energy stored by the amplifier by the formula $k - \frac{\sigma}{h\nu}E$, where σ
is the cross section of stimulated radiation, $h\nu$ is the energy of a quantum
of amplifier radiation. Comparison of experimental data including measured
values of kl is used to construct empirical functions which can be used to
design lasers with various amounts of stored energy in relationship to
input signals. Data are presented for type GLS-1 and GLS-22 glass with
densities of amplified radiation of up to 10 J/cm^2 at a pulse length of
about $3 \cdot 10^{-8}$ s. Figures 5; references 5 Russian.

TEMPERATURE VARIATION OF THE THRESHOLD OF LASING IN AN INJECTION LASER WITH
AN EXTERNAL RESONATOR WITH FIXED RADIATION WAVE LENGTH

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[Abstract] A study is made of the influence of temperature on the lasing
threshold in an injection laser with an external dispersion resonator at
fixed radiation wave length in the temperature region above room temperature.
The active element used was a diode with unilateral AlGaAs/GaAs hetero-
structure. The diode resonator length was 300 μm, and the reflection at
one end of the resonator was reduced by application of a quarter-wave film

of silicon monoxide in a vacuum. This reflection-reducing coating allowed the lasing threshold in internal modes of the diode to be increased from 25 to 100 kA/cm^2 (300 K). Coupling of the diode to the external resonator allowed reduction of the threshold with optimal tuning to 45 kA/cm^2. The spectral tuning interval of narrow-band radiation (about 0.1 nm) was approximately 20 nm. Measurements gave the temperature dependence of the threshold of narrow band lasing at fixed wave lengths in the area of temperatures above room temperature. These curves show the transition through the minimum of the threshold. A mode of anomalous delay was observed at the low-temperature edge of the operating interval. Figure 1; references 5: 3 Russian, 2 Western.

SPECTRUM OF CHANGES IN ABSORPTION OF GaAs NEAR THE ABSORPTION EDGE IN THE FIELD OF RADIATION OF A PULSED CO_2 LASER

BONCH-BRUYEVICH, A. M., RAYKHMAN, B. A. and SMIRNOV, V. N.

[Abstract] Results are presented from a study of the spectrum of the changes of the absorption of nonpolarized radiation with $\hbar\omega_1$ near the absorption edge of GaAs under the influence of pulses of radiation of a CO_2 laser. On the assumption that the changes in absorption resulted from a 2-photon processes, the coefficient of 2-photon absorption β was estimated. The level of the Cr impurity was at least 2 or 3 orders of magnitude lower than in previous experiments. Figure 1; references 8: 7 Russian, 1 Western.

EFFECTIVENESS OF PUMPING A FAST-FLOW CO_2-LASER WITH AN ALTERNATING-CURRENT DISCHARGE

GAVRILYUK, V. D., GLOVA, A. F., GOLUBEV, V. S., and LEBEDEV, F. V.

[Abstract] Industrial laser machining of materials requires CW CO_2-lasers capable of delivering 10 kW at a high efficiency and high reliability. Pumping with an alternating-current discharge that simplifies the cathode design to only a few (two) segments, can be produced with a compact motor-generator set through a step-up transformer, involves the use of capacitive

ballasts without the heat dissipation problem, and makes a spatially uniform transverse discharge easily attainable so that an optically homogeneous medium will be established. Alternating-current discharge is characterized by the existence of two phases--self-maintained and a semi-self-maintained--a consequence of variations in the electric field intensity and thus in the ionization rate during one half-period of the current. Such a discharge in technical nitrogen (containing 2.5% O_2) was studied for the purpose of optimizing its parameters. Efficiencies above 50-60% were attained under pressures of 40-70 mm Hg at a power input of 300 J/g, at which the pumping power had reached its saturation level. Figures 1; references 7: 3 Russian, 4 Western.

KOCHUBEY, S. A., LISITSYN, V. N., SOROKIN, A. R., and CHAPOVSKIY, P. L., Institute of Semiconductor Physics, Siberian Division of the USSR Academy of Sciences, Novosibirsk

[Abstract] A high-pressure (4 atm) laser on an Ar:He= 1:75 mixture was tested at the 0.91 µm line corresponding to the argon I transition. The results indicate that this or other gas lasers with double transverse discharge excitation can be used for tuning the radiation frequency within the range of the impact-widened line, although this range is much narrower than in the case of crystal lasers. Their main application will, therefore, be limited to spectroscopy very close to atomic lines, where they also offer excellent time and spectral resolution. Figures 4; tables 1; references 10: 4 Russian, 6 Western.

ABAKUMOV, G. A., VOROB'YEV, S. A., and SIMONOV, A. P., Physicochemical Institute imeni L. Ya. Karpov, Moscow

[Abstract] During intensive photoexcitation of dissolved organic compounds the occupancy of lower electronic states (singlet, triplet) increases

appreciably. When the pumping radiation is absorbed by excited molecules, then the efficiency of excitation from the ground state to fluorescence decreases. Induced absorption raises the threshold and lowers the efficiency of emission. An experimental study was made of several organic substances in organic solvents: BBO (in benzene), POPOP (in cylcohexane), NPO (in ethanol), perylene (in cyclohexane), uranin (in ethanol), acridine red (in ethanol), rhodamine 6G (in ethanol), 9,10-diphenyl anthracene (in cyclohexane), and N-phenylacridone (in ethanol). Determined were the relative quantum fluorescence and the transmittivity of the solution as functions of the pumping intensity, the pumping pulse shape at various levels of excitation power, the excitation threshold and the emission efficiency as functions of the substance concentration, the emission efficiency as a function of the excitation intensity, and the intensity of spontaneous fluorescence and the emission efficiency as functions of the pumping power (with rhodamine dissolved in water). The results of measurements are compared with theoretical curves calculated on the basis of the equations of emission kinetics for laser models on the same substance. Figures 6; tables 1; references 15: 9 Russian, 6 Western.

LIMITING THE PULSE REPETITION RATE IN PERIODIC-DUTY CO_2-LASERS

BARANOV, V. YU., BREYEV, V. V., MALYUTA, D. A., and NIZ'YEV, V. G.

[Abstract] The main advantage of periodic-duty pulsed CO_2-lasers is their capability of delivering megawatts of peak power at comparatively low average power levels. Here the processes which may be responsible for limiting the pulse repetition rate of such lasers are analyzed; they include: isentropic expansion of the hot gas in the upstream direction, together with the effects of diffusion and heat conduction, shock waves and the transient temperature field behind the wave fronts, and boundary layers building up on the electrodes. Figures 6; references 11: 3 Russian, 8 Western.

AN ELECTRON-BEAM PUMPED CO_2-LASER OPERATING IN THE CORE OF A STEADY-STATE NUCLEAR REACTOR

BATYRBEKOV, G. A., DANILYCHEV, V. A., KOVSH, I. B., MARDENOV, M. P., and KHASENOV, M. U., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow Institute of Nuclear Physics, Academy of Sciences of the Kazakh SSR, Alma-Ata

[Abstract] First experimental results are reported on the performance of a CO_2-laser with electron-beam pumping in the core of a steady-state nuclear reactor. The $CO_2:N_2:He^3 = 1:4.5$ gas mixture was ionized by the products of the $He^3 + n \rightarrow p + T + 0.76$ MeV nuclear reaction. The laser was installed with the discharge gap concentrically in the center channel of the core of a water-cooled water-moderated nuclear reactor. The characteristics of continuous-wave and pulse discharges at various intensities of the thermal neutron flux were measured, including the voltage-current characteristics and the power density of continuous pumping as a function of the neutron flux at various ratios of electric field intensity to gas pressure. With the flux increasing to about $5 \cdot 10^{12}$ neutrons/(cm$^2 \cdot$s), the voltage-current characteristics changed from classical ones (Thompson) to linear (ohmic) ones and so indicated a high-current semi-self-sustained discharge excited by the electron-beam method. With fluxes of more than $2 \cdot 10^{13}$ neutrons/(cm$^2 \cdot$s), the pumping power of the gas mixture at atmospheric pressure was sufficient for cw emission. At the top reactor power, corresponding to about 10^{14} neutrons/(cm$^2 \cdot$s), the power density in the pulse mode exceeded 500 W/cm^3 in a field of 5 kV/cm. At a pressure of 0.5 atm, on the other hand, the cw emission threshold was reached with a pumping power of about 300 W/cm^3 in a flux of 10^{13} neutrons/(cm$^2 \cdot$s) and with a pumping power of about 700 W/cm^3 in a flux of 10^{14} neutrons/(cm$^2 \cdot$s). Only pulse emission could be excited at such reactor power levels. Figures 3; references 9: 7 Russian, 2 Western.

PULSED STIMULATED EMISSION ON THE 472.2 nm LINE OF THE BISMUTH ATOM

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[Abstract] Bismuth is one of the elements on whose vapor pulsed emission can be achieved during transition from a resonance to a metastable level.

The power and the efficiency of such emission on the blue bismuch line could be high and comparable to those of a copper vapor laser. Experiments similar to those performed with lasers on copper, gold, manganese, and lead vapor in the self-heating mode have produced both superluminescence and emission on the 472.2 nm line, with discharge in a noble gas or in a nitrogen-helium mixture. The power of this radiation increases with decreasing pressure, 2.5 torr being about the lowest under which bismuth vapor will not appreciably escape from the active zone. The gain here is much lower than in other lasers of this kind, probably because of the annular patterns of stimulated emission. This could in turn be due to the presence of Bi_2 molecules alongside Bi atoms in the vapor. Figures 1; references 1 Western.

GYUZALYAN, R. N., SARKISIN, and TER-MIKAYELYAN, M. L., Institute of Physical Research, Academy of Sciences of the Armenian SSR, Ashtarak

[Abstract] A picosecond laser with a wide range of frequency tuning has been developed on an $LiIO_3$ crystal and found suitable for many low-power applications such as atmospheric and biological research. Pumping with an Nd-laser of about 1 GW power at the $\lambda = 1.06$ μm wavelength produces a spectral line which can be frequency tuned over the 350-680 nm range by changing the direction of propagation of the $\lambda = 1.06$ μm wave relative to the Z-axis of the crystal through an angle of 27° from 51 to 24°. The spectral bands corresponding to stimulated emission of the second harmonic at $\lambda = 530$ nm, even with large deviations of the crystal from the angle of phase synchronism, are 630-670 nm and 420-450 nm. The spectral width of this tunable radiation is approximately 50 cm^{-1} over the entire tuning range. The power peaks near $\lambda = 500$ nm to about 200 kW and drops to about one fourth of this level within the ultraviolet and the infrared radiation. A specially cut $LiCHOO \cdot H_2O$ crystal yields a tuning range from 500 to 600 nm. Figures 3; references 9: 8 Russian, 1 Western.

UDC 621.373.826.038.825:621.314.26

TUNING THE FREQUENCY OF Nd-LASER RADIATION BY THE METHOD OF RESONANCE PUMPING
OF YAG CRYSTALS ACTIVATED WITH Tm^{3+} and Ho^{3+} IONS

ANTIPENKO, B. M., VORONIN, S. P., MAK, A. A., PIS'MENNYY, POLIKARPOVA, V. N.,
and TOMASHEVICH, YU. V.

[Abstract] A study was made to determine the feasibility of lowering the
radiation frequency of a neodymium laser by means of yttrium-aluminum-garnet
crystals activated with rare-earth ions. The Yb^{3+} ions in such crystals ensure
a sufficiently high coefficient of active absorption at the $\lambda = 1.06$ μm
wavelength. In crystals with a high concentration of Yb^{3+} ions this ensures
an efficient use of pumping radiation from a small active cell. Tests were
performed with 0.1 wt.% Ho^{3+} or Tm^{3+} as activating ions. The excitation
energy threshold was measured for a resonator with given parameters, and
found to be much higher than theoretically predicted. Also the pumping
energy and the energy of stimulated emission as well as the major losses
were measured. Figures 2; tables 1; references: 2 Russian.

UDC 631.375.82

CONCURRENCE OF ORTHOGONALLY POLARIZED MODES IN A RING LASER WITH NONLINEAR
ABSORPTION

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Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] An experimental study was made of concurring orthogonally polarized
modes in a two-mode gaseous ring laser. The resonator of this He-Ne ring laser
with transition from the $\lambda = 3.39$ μm wavelength was built with four mirrors
and an overall perimeter equal to 0.75 cm, the gas-discharge tube 25 cm long
and the absorption tube 30 cm long. Methane under low pressure was used as
the nonlinearly absorbing medium. Beats were produced by mixing in an external
interferometer. The two modes were found to coexist within the region of sharp
change in resultant intensity. The range of two-mode stimulated emission
depends on the pressure in the active medium and on the pumping level. As
this pressure rises to the critical level, one mode is suppressed. A suf-
ficiently high level of reflection inside this resonator was found to estab-
lish a phase relation between modes which are symmetric with respect to the
center line of mode amplification, thus causing an energy transfer from the
stronger mode to the weaker one and resulting in resonance within the region

of unidirectional two-mode emission. The intermode distance between orthogonal modes can be varied from 0 to c/2L (L - overall perimeter of the resonator) by means of a wedge of crystalline quartz, for instance, so that the frequency range of unidirectional two-mode emission can be shifted within the limits of Doppler broadening. Figures 5; references: 5 Russian.

CHEMICAL LASER IN THE VISIBLE RANGE OF WAVELENGTHS BASED ON THE USE OF
AN OXIDATION REACTION

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[Abstract] One method of producing a chemical laser within the visible range of wavelengths is by means of bimolecular exothermal reactions. The requirement of realizing predominantly electron-excited particles narrows the number of suitable reactions down to a few only, including the oxidation of alkali-earth metals. Considering that the reacting components must form compounds either gaseous or volatile under normal conditions, that metastable states with a radiation lifetime within 10^{-3}-10^{-4}s must occupy an elementary reaction event, and that a laser electronic transition must end at a sufficiently high vibrational level of the ground state, germanium and tin have been found most appropriate on the basis of a theoretical and experimental analysis of the reactions. Calculations of the laser performance indicate that effective thermal triggering can occur even at 1000-1500 K and that the efficiency of conversion from infrared radiation at 10.6 μm to visible radiation is sufficiently high (up to 50%). Silicon was also considered but not found as practical. Figures 1; tables 2; references 19: 8 Russian, 11 Western.

GENERATION OF ULTRASHORT PULSES IN A LASER WITH NEGATIVE FEEDBACK

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conductor Physics, Siberian Division, USSR Academy of Sciences, Novosibirsk

[Abstract] For an analysis of intermode self-locking in a solid-state laser with negative feedback, it is necessary that the losses in the model of such

a laser be concentrated rather than distributed. The simplest model is considered here, namely a traveling-wave device describable by equations analogous to equations of equilibrium with one boundary constraint (periodicity) and retaining the basic characteristics of a laser with a Fabry-Perot resonator. The equations are solved here analytically for the amplitude increment and instability conditions. The various time delays in an actual device affecting intermode locking and beats have been determined experimentally and the results are now reconciled with theory. A passive filter combined with the negative feedback seems to be desirable. Proper matching of the time delay in the negative feedback loop will yield a controllable single pulse and the filter will narrow this pulse down to the required limit. Figures 2; references 4: 2 Russian, 2 Western.

KONYUKHOV, V. K., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The gaseous medium of a gas-dynamic laser is the three-component mixture consisting of molecular nitrogen (80-90 vol.%) with a long vibrational relaxation time, molecular carbon dioxide (5-10 vol.%) with a short vibrational relaxation time, and molecular water vapor (1-2 vol.%) with an even shorter vibrational relaxation time. The N_2 molecule provides the excitation, the CO_2 molecule is the source of radiation and water vapor shortens the lifetime of CO_2 molecules at the lower laser level and accelerates transition of these molecules to the ground state. A low concentration or absence of water vapor will weaken this transition and reduce the laser efficiency, while a high concentration of water vapor accelerates relaxation of CO_2 molecules and thus deactivates N_2 molecules. The fundamental equations of laser power and laser kinetics are formulated on the basis of these considerations. The system of kinetic equations is then solved for an optical cavity with a strong electromagnetic field. The models of a uniform field (type I) and nonuniform field (type II) represent the two extreme versions of practical optical cavities. Their efficiency is calculated as a function of their design parameters, which are then optimized appropriately. Although the conversion efficiency of a type I resonator is consistently higher than that of a type II resonator, the difference is not very appreciable. In both cases a high efficiency is attainable only at a level far above the self-excitation threshold. Figures 4; no references.

OPTICAL RECTIFICATION IN AN EXTERNAL RESONATOR

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[Abstract] Static polarization during optical detection can be amplified by
means of a nonlinear crystal inside a Fabry-Perot resonator. The efficiency
of the optical detector depends on the losses in the resonator, some of which
are calculated here theoretically on the basis of a Gaussian incident radiation
line. They include absorption of light in the crystal volume, nonparallelism
of mirrors, oblique incidence of plane waves, angular divergence of incident
light beams, and rotation of the crystal relative to the resonator mirrors.
Some factors affecting the efficiency of the system could only be evaluated
experimentally. Accordingly, the characteristic of static polarization has
been measured for a mirror with the reflection coefficient r^2=85% in an
experiment with optical rectification in an external resonator. Figures 5;
tables 1; references: 2 Russian.

CHEMICAL DF-CO$_2$ AMPLIFIER OF SHORT LIGHT PULSES

BASHKIN, A. S., GRIGOR'YEV, P. G., IGOSHIN, V. I., NIKITIN, V. YU., and
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[Abstract] The chemical DF-CO$_2$ laser-type amplifier on a D$_2$+F$_2$+CO$_2$+He mixture
has been proposed for generating nanosecond pulses. Here energy is transferred
from DF* molecules to CO$_2$ molecules, and the problem of superluminescence
during inversion excitation of the CO$_2$ molecules is not as critical as in the
case of HF* molecules supplying the energy. The feasibility of this device is
determined by the amount of energy that the system of CO$_2$ molecules can store
during chemical pumping and by how the output energy density as well as the
efficiency of the laser system depend on both time and energy characteristics
of the amplified signal. Accordingly, calculations are shown here which yield
the process kinetics in a D$_2$:F$_2$:CO$_2$:He= 1:1:4:5 system where dissociation of
F$_2$ molecules by a fast electron or a light beam triggers the chain reaction.
The results are only approximate, inasmuch as losses in the optical system
and nonuniform reaction triggering over the volume have not been taken into
account. A determination of these factors requires a more thorough analysis
and special experiments. Tables 3; references 10: 7 Russian, 3 Western.

LASER PLASMA AS A SOURCE OF SOFT X-RADIATION

ANAN'IN, O. B., BYKOVSKIY, YU. A., KANTSYREV, V. L., KOZYREV, YU. P., and
RASPOPIN, A. M., Moscow Engineering-Physics Institute

[Abstract] A study was made of soft x-radiation coming from the plasma of
a neodymium-glass laser. The physical aspects of the phenomenon as well as
the practical feasibility of establishing such a source of soft x-radiation
were considered. In the experiment the radiation was focused on a target
surface by means of a lens, all inside a vacuum chamber. The energy conversion
efficiency was determined for targets of various materials, with neither gases
absorbed in the surface layer nor oxide films built up on the surface found to
affect the intensity of soft x-radiation. The electron temperature of the
laser plasma was determined with the aid of aluminum filters. The spatial
distribution of the radiation intensity was found to be uniform over a solid
angle of 2π sr within the given range of wavelengths. The source dimensions
were determined through a camera obscura with a uniform resolution. In
practical applications it would be desirable to control the source size,
possibly by varying the residual pressure in the vacuum chamber. Figures 1;
references 17: 14 Russian, 3 Western.

EXPERIMENTAL DETERMINATION OF THE SATURATION PARAMETER FOR A CW ELECTRIC-
DISCHARGE CO-LASER

LOTKOVAM, E. N., OSTROVSKAYA, L. YA., and SOBOLEV, N. N., Physics Institute
imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The maximum power delivered by cw electric-discharge CO-laser
depends on the saturation parameter, characterizing the rate of decrease of
power gain with increasing radiation density, and on the transmission
coefficient of the resonator mirror through which it is coupled out. This
saturation parameter (W/cm) has been determined on the basis of power, gain,
and pressure measurements in a $CO:N_2:He:Xe:O_2$ mixture under flow-through
and seal-off conditions, the composition of this mixture having been opti-
mized to 1:6.7:28:0:67:0.04. At the same time were also measured the
unsaturated gain and the power loss in the resonator cavity. The error was
found to be within 15%, essentially due to the limited instrument sensitivity
and interference effects during reflection. The wide variance of the percent

power loss is attributed to a contamination of the tube walls by solid products of chemical reactions occurring in the discharge region. Theoretical calculations for the most intensive transition line $\nu = 1815$ cm^{-1} in the flow-through mode under the optimum pressure p= 22 mm Hg with i= 20 mA at V= 9.6 kV yield an output power of 1.5 W. The experiment under p= 17.8 mm Hg with i= 20 mA at V= 8.4 kV yielded a saturation parameter ranging from 7.5 to 60 W/cm, a saturation power ranging from 0.8 to 6.4 W, a power loss ranging from 2.6 to 4.2%, an unsaturated gain ranging from 0.0013 to 0.0016 cm^{-1}, and a maximum power ranging from 0.01 to 0.096 W/cm^3, the top performance corresponding to the 1815 cm^{-1} transition line and dropping somewhat at the lines 1836 and 1782 cm^{-1}. The performance was much lower in the seal-off mode of operation. Figures 2; tables 1; references 12: 4 Russian, 8 Western.

AXIAL MODE LOCKING IN A CW SOLID-STATE YAG:Nd^{3+}RING LASER

KORNIENKO, L. S., KRAVTSOV, N. V., and SHELAYEV, A. N., Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov

[Abstract] The first results are reported on the phase locking of modes in a cw solid-state ring laser (YAG:Nd^{3+}), upon insertion into the resonator cavity of an optoelectronic phase modulator (LiNbO$_3$) operating at the intermode beat frequency (with c/L= 256 MHz). Pumping was provided in this experiment from the arc of a krypton lamp. The study has revealed that forced phase locking of axial modes by means of such a phase modulator is feasible over a10 kHz range of deviation of the modulation frequency from the intermode beat frequency. Furthermore, the frequency characteristics of a rotating laser crystal reveal a larger amplitude of the difference-frequency signal and a narrower locking band than in the case of free emission. Also the possibility of spontaneous locking without resonant excitation was discovered in the experiment. Figures 2; references: 8 Russian.

LASER RADIATION FROM CdS SINGLE CRYSTALS WITH ONE-PHOTON EXCITATION

KRITSKIY, A. V., KRUPA, N. N., and KUPCHENKO, G. A., Institute of Physics, Academy of Sciences of the Ukrainian SSR, Kiev

[Abstract] Laser emission at 300, 77, and 1.4 K was produced and examined in CdS single crystals, 10-50·10^{-4} cm thick plane-parallel wafers with a

donor concentration of the order of 10^{15} cm^{-3}. A 0.1 cm long resonator between
the end planes had been produced by cleavage along the C-axis. The surfaces
of these crystals were excited with 2 kW strong and 10^{-8} s long pulses from
a N$_2$-laser with a repetition rate of 100 Hz. The generation rate of electron-
hole pairs at the surface reached the 10^{29} cm^{-3}s^{-1} level. Radiation spectra
were recorded with a model DFS-1 spectrograph on photographic film, and then
compared with measurements of the absorption coefficient at respective
emission frequencies. Stimulated emission on the P-line has been established,
also at the M-line at 1.4 K, as a result of transition due to exciton-exciton
scattering and intermolecular scattering respectively. The excitation threshold
was found to become lower with decreasing temperature. Figures 1; references
14: 7 Russian, 7 Western.

USSR

POSSIBILITY OF THE MASER EFFECT IN PARAMETRICALLY EXCITED ANTIFERROMAGNETICS

OL'KHOV, O. A. and LUTOVINOV, V. S., Institute of Chemical Physics, USSR
Academy of Sciences, Moscow

[Abstract] One branch of the spectrum of electronic spin waves in antiferro-
magnetics with a plane of easy magnetization falls within the microwave range.
An external microwave field can, therefore, parametrically excite not only
a pair of magnons within an electronic branch but also magnetostatic oscil-
lations, pairs of nuclear spin waves, and various combinations of these
effects. With the occupancy of the excited branch larger than that of a
lower branch, an inverted state can result and the crystal will reradiate
electromagnetic energy at a frequency equal to the energy difference between
the two branches. Such a reradiation effect due to resonance transitions
between an electronic branch and a nuclear spin branch as well as between
two magnetoelastic branches of the spectrum is analyzed here starting with
the Hamiltonian description of interaction. The specific case of an MnCO$_3$
crystal is considered at T= 1.5 K with pumping at the frequency of 36 GHz.
The high value of the negative magnetic susceptibility suggests the feasi-
bility of utilizing this maser effect for a wider scope of parametric
spectroscopy. Since the reradiated power is proportional to the occupancy
of parametrically excited states, this maser effect can also, at least in
principle, be applied to amplification of weak signals. Figures 1;
references 12: 11 Russian, 1 Western.

TWO-PLASMON DISINTEGRATION AND GENERATION OF THE $\frac{2}{3}\omega_0$ HARMONIC

SILIN, V. P. and STARODUB, A. N., Physics Institute imeni P. N. Lebedev at the USSR Academy of Sciences

[Abstract] The instability limit of a nonhomogeneous plasma, with respect to the splitting of the pumping wave into two plasmons, is calculated from a basic equation which contains complete elliptic integrals of both the first and the second kind. This equation also accounts for the effect of non-uniform plasma density on the excitation of plasmons, this effect increasing from negligible for plasmons with large wave number to predominant for plasmons with small wave numbers. On the basis of this analysis is prediced generation of the $\frac{3}{2}\omega_0$ harmonic, with an intensity threshold. The increment of plasmon splitting is also calculated and it is shown that the radiation intensity at this harmonic frequency depends on the energy flux density in the incident laser light beam. Earlier experimental results are explained by an increase in the energy flux density to a level at which the smallest wave vector of a plasmon becomes comparable in magnitude with $2\pi/\lambda_0$. Figures 1; references 11: 6 Russian, 5 Western.

AMPLIFICATION OF POLYCHROMATIC PUMPING DURING STIMULATED RAMAN SCATTERING

DZHOTYAN, G. P., D'YAKOV, YU. YE., ZUBAREV, I. G., MIRONOV, A. B., and MIKHAYLOV, S. I., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR

[Abstract] An experimental study was made on the basis of the theory of stimulated Raman scattering with the involvement of multimode pumping fields and a Stokes wave, to explain broadening of the spectrum of a narrow-band Stokes signal during amplification in a wideband pumping field. The test apparatus included two synchronized neodymium lasers with Q-switching by Kerr cell. The results reveal the physical mechanism of interaction between incoherent beams during stimulated scattering. The incoming Stokes beam forms a signal with characteristics identical to those of the pumping beam and thus most easily amplified. With a sufficiently high excitation intensity and a sufficiently long interaction zone, therefore, the amplified Stokes signal will almost completely duplicate the pumping characteristics. This physical model is also applicable to interaction between multimode waves and yields a satisfactory quantitative agreement between theory and experiment in the case of high amplification at intensities above the critical. Figures 5; references 9: 7 Russian, 2 Western.

HEAT EXCHANGE IN AN MHD CHANNEL CONSIDERING ION SLIP

MITTAL, M. L., and BHAT, A. N., Bombay Technological Institute, India

[Abstract] Ion slip is very important in an MHD generator which uses a
partially ionized gas. This work studies the influence of ion slip on the
distribution of temperature in the area of the initial thermal sector with
constant wall temperature. To provide a complete description, axial heat
conductivity, ohmic heating and viscosity dissipation were considered. The
problem is solved analytically. Numerical values are presented of the heat
exchange coefficients for various values of parameters characteristic for
MHD generators. It is concluded that ion slip causes a change in the
distribution of temperature and a decrease in the length of the initial
thermal sector, mean mass temperature and local Nusselt number. Figures 5;
references 13: 3 Russian, 10 Western.

DETERMINATION OF THE PARAMETERS OF A PLASMA ON THE BASIS OF LOW-FREQUENCY
FLUCTUATIONS OF SCATTERED LIGHT

ZHURABLEV, V. A., KARPOV, O. V., PETROV, G. D. and YURCHUK, E. F., National
Research Institute for Physics and Technology

[Abstract] A theory and method are suggested for determination of the parameters
of a plasma on the basis of fluctuations in the intensity of scattered radiation
collected from a rather small volume. The temperature of ions in the jet of an
argon plasmotron is measured with various currents and gas flow rates. The
characteristic size of the scattering volume is equal to the diameter of the
focal spot in the experimental installation, which was measured by the track
left by the radiation on aluminum foil. The focal spot was 0.96 mm in
diameter, the longitudinal dimensions of the measured volume, determined by
the field of vision of the collecting optical system, was 1.5 mm. With these
dimensions, fluctuations in intensity can only be caused by waves propagating
along the axis of the plasma. Figures 3; references 9: 7 Russian, 2 Western.

STUDY OF THE EFFECTIVENESS OF A FARADAY MHD GENERATOR IN COMBINATION WITH A THERMONUCLEAR REACTOR

BREYEV, V. V., PANCHENKO, V. P. and CHERNUKHA, V. V., Institute of Nuclear Energy imeni I. V. Kurchatov

[Abstract] A study is presented of the method of design of highly effective MHD generators for thermonuclear power plants, and the influence of certain factors on the effectiveness of their operation is studied. The problems of producing maximum effectiveness with an equilibrium plasma, and of assuring high parameters of the working fluid are discussed. A quasi one-dimensional method of design of such generators is presented. Supersonic MHD generators using various working fluids (water, argon and helium with admixtures of potassium and lithium) are studied. It is shown that a Faraday MHD generator with a stationary plasma source can provide high values of thermonuclear electric power plant efficiency (60-80% when low-potential heat is utilized). Figures 4; references 10: 9 Russian, 1 Western.

PHASE FOCUSING OF A DENSITY-MODULATED ELECTRON BEAM IN A PLASMA

GLADKIY, A. M. and KOVALENKO, V. P., Institute of Physics, Acad. Sci. Uk SSR, Kiev

[Abstract] A study is made of the interaction of an electron beam with a plasma with slight modulation of the beam current density at the point of injection. A one-dimensional plasma with cold electrons and stationary ion background is studied, using the equation of charge conservation and the equation of electron mobility to determine the spatial variation of beam current density. It is found that strong bunching of the beam occurs at a certain coordinate where the amplitude of oscillations in the function which is to be determined is near unity. Preliminary modulation of beam density leads to the same effect as modulation of beam velocity, although the expression for the coordinate for the phase focal point is different. Both calculated and experimental data indicate that with slight modulation of beam density, phase focusing of the beam occurs with amplification of the oscillations. Figure 1; references 4: 3 Russian, 1 Western.

EXCITATION OF COHERENT ELECTROMAGNETIC RADIATION BY A RELATIVISTIC ELECTRON BEAM IN A PLASMA WITH A FREE SURFACE SURROUNDED BY A METALLIC SHEATH

IVANOV, S. T.

[Abstract] A plasma cylinder inside a metallic cylindrical waveguide is considered, with a relativistic electron beam traveling along the axis. The electron concentration in the beam is much lower than in the plasma so that the beam can excite natural oscillations in the plasma. An external magnetic field confines the electron beam within a fixed radius, and the plasma is either not magnetized with isotropic permittivity or strongly magnetized with orthotropic permittivity. In both cases the development of instability is analyzed on the basis of the dispersion equation for small oscillations in a system with two dielectrics (plasma and vacuum) surrounded by a sheath. The analysis of various modes in this system indicates that such a sheath around the free plasma surface contributes to the excitation of coherent electromagnetic radiation in a strongly magnetized plasma only. This excitation has a resonant characteristic and the efficiency of electron beam energy to electromagnetic radiation energy conversion is higher than without a sheath. References 5: 3 Russian, 2 Western.

FEASIBILITY OF PRODUCING FAST CHARGED PARTICLES BY ELECTRIC-ARC DISCHARGE IN A VARIABLE-DENSITY GAS

TARASOVA, L. V., Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] Studies of discharge in slightly nonuniform electric fields between a small spherical cathode and a plane anode a few centimeters apart, with kiloampere currents flowing through the interelectrode gap, indicate that further improvements in subnanosecond discharge techniques should make it feasible to generate large currents of electrons leaking from the plasma into air under atmospheric pressure and to produce doses of x-radiation adequate for many practical applications. The necessary pressure drop and thus a variable-density profile can be attained by feeding the gas through a nozzle on the cathode and constantly maintaining near-zero pressure in the vacuum chamber. The necessary overvoltage at the cathode is attained as a result of this pressure drop in combination with a nonuniform electric field intensity which also decrease from cathode to anode. Figures 2; references 10: 9 Russian, 1 Western.

A SYSTEM FOR PRODUCING A UNIFORM MAGNETIC FIELD IN THE GOL-1 FACILITY

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Division of the USSR Academy of Sciences, Novosibirsk

[Abstract] The GOL-1 facility has been built at the Institute of Nuclear
Physics, for a study of plasma heating with a high-current relativistic
electron beam and plasma containment by means of a strong magnetic field
of multiple-mirror configuration. One concern in the design of this device
was the feasibility of producing a uniform magnetic field of up to 2.4×10^6 A/m
within the active zone of the test chamber. The system developed for this
purpose consists of a capacitor-resistor discharge bank with grounding as
the energy source, a set of trigatron rectifiers with synchronization as
the current commutator, and a coaxial solenoid with field correction and
current taps as the load. All three components are shown here schematically
and pictorially, their construction is described and their operation is
explained. Figures 7; references 2: 1 Russian, 1 Western.

Molecular Physics

RADICAL DECOMPOSITION OF HYDROGEN PEROXIDE ON SOLID SURFACES

GRIGORYAN, G. L. and NALBANDYAN, A. B., Institute of Chemical Physics,
Academy of Sciences of the Armenian SSR, Yerevan

[Abstract] Organic peroxides are unstable compounds and during reactions in
which they act as oxidizers there may also form hydrogen peroxide. The latter
is known to decompose into water and oxygen on various solid surfaces. An
experimental study was made of this heterogeneous decomposition, the method
based on freezing out and building up the radicals (H_2O) on surfaces of
molybdenum, Pyrex, quartz glass, and metallic platinum. The temperature
dependence of the reaction rate and the anomalies in its trend, somewhat
different in each case, indicate that the final molecular decomposition
proceeds through various elementary radical stages, but with only a portion
of the active free radicals having sufficient time to penetrate from the
surface into the bulk of the substrate. Figures 3; references 4: Russian.

LOCALIZATION OF VIBRONIC EXCITATION ENERGY AND ROLE OF THIS PHENOMENON
IN SELECTIVE LASER CHEMISTRY

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L. Ya. Karpov, Moscow

[Abstract] The high density of vibrational sublevels in polyatomic molecules
inhibits a selective photochemical process associated with breaking a given
bond in the electronic ground state. A method has been proposed by which
selective photochemical conversion of polyatomic molecules in excited
vibronic states is possible. This method is based on the localization of
vibronic excitation energy. An analysis of this phenomenon reveals that a
selective change in the equilibrium positions of only some active oscillators
in a molecule occurs during electron transitions in various orbital modes.
The number of active oscillations which form vibronic spectra thus becomes
much smaller than the total number of normal vibrations in a molecule. A
subsequent analysis of transition and reaction probabilities indicates the
feasibility of various selective photochemical conversions (e.g., of ketones,
quinones, and their derivatives), of effective photochromy, of polymerizing
and polycondensing certain compounds, of initiating catalytic reactions,
and of separating isotopes under various conditions (in gaseous, liquid, or

crystalline state at various temperatures). At low temperatures or in the adsorbed state the use of triplet states with long lifetimes may appreciably improve the effectiveness of this method. Figures 1; references 11: 9 Russian, 2 Western.

DISSOCIATION OF SF_6 MOLECULES UNDER RADIATION FROM A PULSED CO_2-LASER IN THE PRESENCE OF HYDROGEN HALIDES

ARKHANGEL'SKIY, YU. I., KLIMOV, V. D., KUZ'MENKO, V. A., LEGASOV, V. A., and NEDOSEYEV, S. L., Institute of Atomic Energy imeni I. V. Kurchatov, Moscow

[Abstract] The dissociation of SF_6 under radiation from a pulsed CO_2-laser (CO_2:N_2:He= 1:1:3, at atmospheric pressure) in the presence of HF, HCl, HBr, HI, and Kr was studied to determine the effect of these additives on the rate of dissociation. The spiked laser pulses had each an approximately 30 ns rise time, and approximately 80 ns duration, a 0.5 μs decay time, and a 35+4 J energy content (10 cm x 7 cm). The activation energy was assumed to decrease in the order HF – HCl – HBr – HI, on the basis of standard enthalpy data. It was found that hydrogen halide molecules are conducive to deactivation of vibrationally excited SF_6 molecules from levels below the dissociative state, according to the collision mechanism. This is explained here in two ways: 1) by the probability of vibrational deactivation being higher than the probability of a bimolecular chemical reaction with a low steric factor, and 2) by the occurrence of a stage below the reaction activating energy level, reached at the end of a laser pulse, which limits the rate of vibrational excitation so that dissociation of SF_6 molecules during subsequent exchange of vibrational energy becomes impossible and the dissociation remains predominantly photochemical. Figures 3; tables 1; references 14: 11 Russian, 3 Western.

THE SIGNIFICANCE OF NUCLEAR REACTIONS IN THE FORMATION OF TRITIUM IN WATER-COOLED POWER REACTORS

ABOLMASOV, YU. P., GOLUBCHIKOVA, I. G. and SAMOYLOVA, T. A.

[Abstract] In water-moderated, water-cooled power reactors, tritium is formed in the core as neutrons bombard impurities contained in the coolent, structural materials of the core itself and in fission of the nuclear fuel. Boron is added to the coolant in the first loop of this type of reactor; several reactions of boron are known which lead to the formation of tritium. The predominant role in the formation of tritium in boron reactions is played by the reactions:

$$^{10}B(n,a)^7 Li; \quad ^7Li(n,n'a)^3H, \text{ and}$$
$$^{10}B(n,2a)^3H.$$
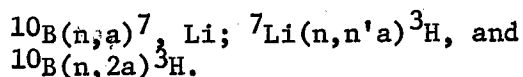
The data produced in an experimental study in sections II-IV of the Novovoronezh Nuclear Power Plant indicate that 10.3-13.8% of the ^7Li formed in the first reaction participates in the process of generation of tritium in the second reaction. Figures 2; references 2: 1 Russian, 1 Western.

EXPERIENCE OF OPERATION OF TRIAXIAL CHAMBERS AT THE LENINGRAD NUCLEAR POWER PLANT IMENI V. I. LENIN

YEMEL'YANOV, I. YA., ALEKSEYEV, V. I., VORONTSOV, B. A., LIPIN, V. F., OL'SHEVSKIY, V. P., POSTNIKOV, V. V. and RYABOV, V. I.

[Abstract] Triaxial fission chambers of two types, designed for measurement of local and integral neutron flux density, respectively, have been in operation in the first section of the Leningrad Nuclear Power Plant for some time. The experience gained in using these chambers is described, with particular attention given to the effect of neutron bombardment on such characteristics as resistance between individual conductors of connecting cables. The reliability of these chambers is high, resulting from the use of a protective electrode in the communication line and in the core, so that the requirements for resistance of the insulation are reduced as well as the simplicity of the design, almost equal to that of emission detectors. Figures 4; references 5: 4 Russian, 1 Western.

RADIATION DAMAGE OF THE STRUCTURAL MATERIALS OF FAST REACTORS

BYKOV, V. N. and KONOVEYEV, YU. V.

[Abstract] The damaging doses per unit of flux in fast breeder reactors with various neutron spectra are compared. The basic results of the study of dose and temperature dependences of swelling of structural steel and the influence of chemical composition and heat and mechanical treatment, as well as problems caused by radiation creep, high temperature embrittlement and interactions with the fission products are discussed. Radiation damage to structural materials under fast breeder reaction conditions arises as a result of the confluence of many mechanisms, determined by the conditions of bombardment, the condition and composition of the material and external factors. This damage significantly influences the mechanical properties and usage characteristics of the material and may influence the economy of fast breeder reactors. The basic problems for improvement of materials and elements for the core zone are problems of accommodation of swelling of structural materials and preservation of sufficiently high mechanical strength at high flux levels. The results to date diverge widely, and the reasons for this divergence need to be understood. Figures 4; tables 3; references 27: 3 Russian; 24 Western.

CIRCUMFERENTIAL UNEVENESS OF RADIATION SWELLING OF THE CLADDING OF PERIPHERAL FUEL ELEMENTS OF A FAST REACTOR

REYTOV, V. F. and FARKHUTDINOV, K. G.

[Abstract] A study was made of the distribution of radiation porosity around the cladding of a periperal fuel element at various points along its length. The nature of the change in structure of the material around the perimeter of the cladding of peripheral and central fuel elements in the area of maximum flux, $2.2 \cdot 10^{22}$ n/cm^2 was compared. The results are sufficient to allow estimation of the change in shape of a fuel element in the process of operation. If it is presumed that each sector of the perimeter of the cladding swells independently of neighboring sections, the relative elongation of the fuel element cladding can be determined and agrees well with experimentally observed elongations. If the elements are very tightly packed and in tight contact with the walls around them, stresses and strains which

develop in them may be sufficient to cause cladding failure. The authors thank Sh. Sh. Ibragimov for his interest in the work and discussion of the results. Figures 5; references 10: 4 Russian, 6 Western.

STUDY OF THE STRUCTURE OF THE FLUX OF IONS LEAVING A 4-LENS ACCELERATOR

ZUBKOV, I. P.

[Abstract] Studies of high-current multiple-lens accelerators are continued on a 4-lens model, which reached accelerating voltages of up to 6 kV. Results are presented from studies designed to determine the structure of the flux of ions leaving the 4-lens accelerator, its energy spectrum and mass composition, as well as the possibility of using additional systems at the output to produce a pure stream of hydrogen ions. The radiation pattern of the ions in the output stream by velocities, its divergence, distribution of ion current density across the cross section, power and mass composition are presented. The total ion current is 60-70% of the discharge current, with up to 75% of the ion flux contained in an angle of 30°. Most of the ions have energies between 1 and 3.5 keV, the spectrum moving upward as the discharge voltage is increased. Experiments on the possibility of using additional systems at the output of the accelerator confirm that good agreement is achieved with calculations based on a single-frequency model of the movement of the ions and no clear collective effects are seen. The author thanks A. I. Morozov and A. Ya. Kislov for valuable discussion and V. A. Aleksanov and Ya. S. Oparin for help in performing the experiments. Figures 8; references: 8 Russian.

MULTICHANNEL ATOMIC ANALYZER WITH ATOMATIC SYSTEM FOR RECORDING OF EXPERIMENTAL DATA FROM THE TM-3 TOKAMAK

BAGAYEV, V. V., IZVOZHIKOV, A. B., KALINKEVICH, I. F., MAYDL', YU. V. and PETROV, M. P., Institute of Physics and Technology imeni A. F. Ioffe, Acad. Sci. SSR, Leningrad

[Abstract] The authors of this article have developed, manufactured and used an automatic system for recording of the results of experiments on the TM-3

Tokamak. The system is used to analyze the flux of atoms from the plasma and measure the ion temperature. The system consists of a pulse-time analyzer with 5-channel input, 20 time channels and a digital printout. The speed of the system is sufficient to record statistical pulses with a frequency of up to 1 MHz. The system is based on a standard type AI-128-2 amplitude analyzer. It has produced detailed data on the value and variation with time of the ion temperature and absolute flux of atoms from the TM-3 Tokamak during the entire duration of its working cycle. The authors thank M. N. Shepelev and G. N. Ploskirev for their help in creating the automatic recording system, and K. A. Razumova and the workers of the TM-3 system for supporting the experiments on the installation. Figures 4; references 8: 6 Russian, 2 Western.

USE OF PHOSPHATE GLASS FOR SEPARATE INTRAREACTOR DOSIMETRY

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[Abstract] For determining the effect of radiation inside a reactor on a substance, one must have separate data on each component of the radiation field. In order to avoid large errors resulting from measurements of mixed γ-radiation and fast neutrons, the dose of the latter can be measured independently of the γ-dose measurement. One such method is based on separate electron-paramagnetic-resonance measurement and γ-spectrometry of radiation effects in silver-activated phosphate glass. In actual experiments, EPR spectra of lithium-aluminum borophosphate glass with Ag_2O exposed to γ-radiation (Co^{60}) and to thermal neutrons, respectively, were recorded within the 3-cm band on a Zeiss spectrometer. With properly calibrated curves of EPR signal intensity and of cumulative activation versus radiation dose, such a phosphate glass can thus be successfully used as a radiation monitor of intensive $n+\gamma$ radiation on intermittently exposed objects. Figures 2; references 8: 4 Russian, 4 Western.

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SELECTION AND PRODUCTION OF MATERIALS FOR ATOMIC ELECTRIC POWER PLANTS
OPERATED WITH DISSOCIATING N_2O_4 COOLANT

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Belorussian SSR

[Abstract] In the selection of materials for atomic electric power plants
operated with N_2O_4 as the coolant, one must consider not only the con-
ventional rules which apply to reactor materials but also the peculiarities
of this coolant. Accordingly, all materials for such a power plant fall
into three categories: structural, fissionable, and neutron-absorbing.
Materials in the first category, mainly stainless steels, must be treated
so as to become both corrosion and radiation resistant. Materials in the
second category, such as uranium dioxide or uranium carbide, are made
corrosion resistant by alloying with zirconium or niobium, by surrounding
with stainless steel cladding, or by dispersion into slugs or spherical
grains and protectivity coating the latter. The treatment of materials in
the third category is, essentially, the same as those of the second category.
References 15: 11 Russian, 4 Western.

INFLUENCE OF ELECTRON DISTRIBUTION DENSITY ON COHERENCE OF THE RADIATION OF
BUNCHES

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of Physics

[Abstract] This work is dedicated to the problem of the radiation of electron
bunches of arbitrary structure with arbitrary movement in homogeneous media.
The general formula produced for the frequency and angular distribution of
radiation intensity is averaged with respect to the arbitrary statistical
distribution function of the electrons in the bunch. The expression for the
mean intensity includes a form factor consisting of the product of two
functions, one of which is independent of the type of radiation and is
determined only by the longitudinal distribution of electron density, while
the other depends on the type of radiation and transverse distribution. In
cases of practical interest, the full form factor is reduced to the former,
longitudinal form factor. The type of form factor clearly indicates a

condition under which the total radiation is significantly greater than the noncoherent portion of the radiation. Expressions are produced and analyzed for the longitudinal and transverse form factors with specifically selected distributions of electron density of practical interest. Values of critical frequencies above which there is no effect of amplification of radiation are found. The spectra of synchrotron, Cherenkov and undulating radiation of electron bunches are studied and it is determined that these spectra are primarily determined by the structure of the clusters and differ significantly from the spectra of noncoherent radiation. The authors thank G. M. Garibyan and the members of the Theoretical Seminar of the Yerevan Institute of Physics for their discussion of the work. Figures 6; references 27: 19 Russian, 8 Western.

KOLESNIKOV, N. N. and VYMYATNIN, V. M., Moscow State University imeni M. V. Lomonosov

[Abstract] The exact values of binding energy must be known for experimental purposes such as identification of new artificial elements and nuclei far from the β-stability line as well as for theoretical calculations. Accordingly, a study has been made of the fine structure of the energy surface and the results of a phenomenological analysis interpreted in terms of quasi one-particle levels. The binding energy of nucleons (protons, neutrons) is considered and the energy surface found to be split within each of its intermagic regions into four parabolic surfaces with equal curvatures, shifted from one another vertically or horizontally. The binding energy is found to be a linear function of Z and N, also in the case of deformed aspherical nuclei. On this basis, with the necessary corrections, an exact general expression for the binding energy is derived and the parameters of nucleon levels are calculated. Figures 2; tables 3; references 24: 10 Russian, 14 Western.

EFFECT OF RADIATION FROM A NUCLEAR REACTOR ON THE ELECTRICAL STRENGTH OF
A THIN-FILM METAL-DIELECTRIC-METAL SYSTEM

BURACHEVSKIY, YU. A., Tomsk Polytechnic Institute imeni S. M. Kirov

[Abstract] A study was made to determine the effect of radiation from a
nuclear reactor on the electrical strength of an aluminum-silicon oxynitride-
aluminum system. A 0.1 μm thick film of silicon oxynitride was deposited on
aluminum by reactive ion sputtering. The specimens were placed in the vertical
channel of a model IRT-2000 reactor delivering a power of 2 MW above 390 K,
where they were exposed to a flux density of fast neutrons increasing from
$1 \cdot 10^{15}$ to $1.2 \cdot 10^{17}$ neutrons/cm^2. The electrical strength was then measured
under a sawtooth voltage, in terms of breakdown voltages corresponding to
successive micropunctures. The breakdown voltage has been found to increase
first, under initial irradiation with $1 \cdot 10^{15}$ neutrons/cm^2, as long as the
annealing of existent microdefects exceeds the formation of new defects.
With further neutron irradiation, the electrical strength decreases because
of structural changes occurring within the dielectric layer. This is
accompanied by an increase in conductivity and a higher loss tangent.
Figures 1; references: 4 Russian.

AN ATTEMPT TO DISCOVER PENETRATION OF GOLD INTO SILICON UNDER NEUTRON
IRRADIATION

DIDIK, V. A. and MALKOVICH, R. SH., Physicotechnical Institute imeni A. F.
Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A study was made to establish radiation from a nuclear reactor
stimulates diffusion of gold into silicon. The experiment used substrates
of p-type silicon doped with boron, 200 μm thick. Their surface, 2-5 cm^2
in area, had been chemically polished to a mirror finish prior to the
deposition of gold films (some deposited chemically, some by vacuum sputtering).
These specimens were placed inside aluminum containers in the dry channel of
a nuclear reactor and there exposed to thermal neutron fluxes at two intensity
levels of $(5-7) \cdot 10^{13}$ and $4 \cdot 10^{12}$ neutrons/$(cm^2 \cdot s)$, along with unclad control
specimens. Subsequent removal of layers by etching and measurement of residual
activity as well as gold concentration as functions of the differential and
total layer thickness did not reveal any penetration of gold into silicon as

a result of neutron irradiation, but an adsorption of gold at the silicon surface during chemical etching away of layers. The hypothesis of radiation stimulated gold diffusion has thus been refuted and the results of earlier studies explained as due to experimental inaccuracy. Figures 3; references 19: 8 Russian, 11 Western.

ALFEROV, V. N., ZARUCHEYSKIY, V. G., KOMOV, V. I., LYAMIN, V. N., CHERNYY, S. A. and YAMPOL'SKIY, I. R., Institute of High Energy Physics, Protvino

[Abstract] The IFVE separator, which forms pure beams of secondary particles for the "Lyudmila" liquid hydrogen bubble chamber, uses a recovery mode of power supply, allowing the intensity of the beams to be increased by reducing the length of deflectors and correspondingly increasing their acceptance, increasing the group velocity of waves in the deflector and thus decreasing the requirements for temperature stability and accuracy of manufacture of the irised wave guide. In the recovery unit described, a matched double T-bridge is used as the power input bridge. The phase shifter is based on an unmatched tourniquet joint and has a reflection factor of not over 0.03 in the 2797.5 ± 3 mHz frequency band. The impedance transformers regulate the reflection factor between 0 and 0.5 throughout the entire phase band. Losses in pulse length are not over 2 μs throughout the entire band of anodic voltages used in the klystron of the device. Operation in three long sessions totalling 2,000 hours showed that at power levels of not over 25 MW, deflector breakthrough practically does not occur. The effectiveness of operation of the separator is near 100%. The authors thank M. B. Vladimirtsov, V. L. Smirnov and B. V. Prosin for their constant attention to the work and useful discussions. Figures 8; references 11: 8 Russian, 3 Western.

USSR

NEW FAST REACTOR

[TASS Report: "Success of Dubna Physicists"]

[Text] At the Joint Institute of Nuclear Research the construction of a new, powerful experimental installation, a fast pulse reactor (IBR-2), was completed and its start-up has begun.

According to its parameters, the IBR-2 is a unique physics instrument designed for research on the structure and property of matter with the help of neutrons. Its power surpasses many times over all the active installations of a similar type in the world. While the average power of the reactor is four megawatts, its power per pulse will be two thousand times greater, which is comparable to the power of several nuclear power plants.

In the planning and construction of the installation, the interests of the scientific-research institutes of Moscow, Leningrad, Obninsk and Dimitrovgrad were taken into account. A system of protective controls was manufactured in Poland. [357]

USSR   UDC 621.039.573

THE RBT-6 RESEARCH REACTOR

TSYKANOV, V. A., AVER'YANOV, P. G., BURUKIN, V. P., ZALETNYKH, B. A., KORMUSHKIN, YU. P., KOROTKOV, R. I., KUSOVNIKOV, A. S. and SPIRIDONOV, YU. G.

[Abstract] The Scientific Research Institute for Nuclear Reactors imeni V. I. Lenin has constructed an immersed-type reactor with a thermal power of 6 MW. The reactor went on line at its nominal power level in late 1975, utilizing spent fuel elements from the SM-2 research reactor. This article describes the design of the reactor and presents a flow diagram and vertical cross sectional drawing. The reactor is simple in design and easily accessible for the conduct of experiments. Considering its low thermal power, the neutron fluxes in it are rather high which, in combination with the great duration of continuous operation which can be achieved allows a broad range of experiments to be conducted. It can be recommended as a research reactor for bombardment of specimens of material up to moderate flux values of 10^{19}-10^{21} n/cm^2 and for studies of the changes in the properties of materials in the process of bombardment. Calculation indicate that the number of spent fuel assemblies provided by the SM-2 reactor is sufficient for the operation of several such smaller reactors. Figures 3; tables 1; references: 4 Russian.

FORMATION OF SHAPE ISOMERS DURING NUCLEAR REACTIONS AND DURING β-FISSION

GANGRSKIY, YU. P., Joint Institute of Nuclear Research

[Abstract] Many quasispherical nuclei have rotational poles, i.e., systems of levels associated with appreciable deformation. This indicates the possibility of a nucleus existing simultaneously in two different shapes, each associated with its peculiar system of levels. Transitions between levels in different systems may be accompanied by changes in the nucleus shape and therefore be retarded. The quadrupole moments and the possibilities of such radiational transitions between levels have been measured so that the hindrance factors for various changes in the deformation can be calculated for specific nuclei, especially the heavy ones ($Z \gtrsim 92$). Studies have also been made to determine how the magnitude of the hindrance factor is influenced by such factors as the nature of the levels, the excitation energy, the height and the width of the potential barrier. Two kinds of radiational transitions are considered: those from an isomeric level to different excitation states, accompanied by intensive γ-radiation emanating from fragments of fission products, and those from different excitation states to an isomeric or any other level within the potential well. The results of these studies indicate that the hindrance factor decreases fast with higher excitation energy, until it almost vanishes at energies above the potential barrier separating both minima, but increases with increasing charge on the nucleus. The values of the hindrance factor are similar for levels excited in different nuclear reactions. Consequently, the hindrance factor depends more on the characteristics of the potential barrier than on the characteristics of individual states. Figures 3; tables 2; references 27: 7 Russian, 19 Western.

SEARCH FOR AND SYNTHESIS OF SUPERDENSE NUCLEI

KARNAUKHOV, V. A., Joint Institute of Nuclear Research

[Abstract] The theory of pion condensation predicts the existence of super-dense nuclei, on the basis of the structure of the nucleon-nucleon potential. The possible properties of such nuclei are reviewed here, namely: their β-stability, the energy of β-fission, the probability of spontaneous splitting, and the mass defect. The α-fission has not been investigated, but the range of stable superdense nuclei and the anomalous Lee-Wick state have been

established. Experimental studies have been aimed at finding such nuclei in natural specimens as well as at synthesizing them in accelerators. At this time experimental research still lags far behind theoretical research, and has not yet produced any positive results. However, the possible existence of superdense nuclei must not be altogether ruled out. Figures 5; references 28: 9 Russian, 19 Western.

KULIKOV, I. S. and TVERKOVKIN, B. YE., Institute of Nuclear Energy, Academy of Sciences of the Belorussian SSR

[Abstract] Reliable fuel elements for operation under highly adverse conditions are the main problem in the design of gas-cooled fast reactors. Fuel elements with a gap between fuel and cladding, due to accumulation of manufacturing tolerances, can become unstable either under a large excess of external pressure or because of creep and geometric irregularities. Cylindrical fuel elements are analyzed here under conditions of creep and radiational dilation of the steel cladding. The basic equations have been derived from the theory of aging and radiational creep. Numerical calculations for austenitic steel under typical operating conditions indicate that the stability of cylindrical cladding is, indeed, largely affected by its initial ellipticity and by the external pressure. Figures 3; references 9: 7 Russian, 2 Western.

DANILOV, A. YE., DEMCHENKO, N. N., ROZANOV, V. B., SKLIZKOV, G. V., and FEDOTOV, S. I., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Spherical symmetry and, particularly, uniformity of the target irradiation must be maintained precisely in designing the optimum heating and implosion of targets in laser-driven thermonuclear fusion. The irradiation

of a spherical target by a single beam is calculated here first according to geometrical optics, without aberrations, and then with small spherical aberrations taken into account. Multibeam geometry is considered next, M groups of L beams on each side of a regular polyhedron (a tetrahedron, a cube, an octahedron, a dodecahedron, or an icosahedron) under the constraint that no beam from a focusing channel enters the laser system bypassing the target. The resultant irradiation intensity and the irradiation nonuniformity factor for some variants of the beam geometry are shown as functions of the coordinates of the target surface and of the aberration. Figures 5; tables 1; references 5: 3 Russian, 2 Western.

PRODUCTION OF SOLID-HYDROGEN TARGETS FOR LASER-DRIVEN FUSION

MARKOV, A. N., FRADKOV, A. B., and CHERNETSKIY, V. D., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Hydrogen and deuterium have been solidified in a special helium cryostat and then extruded through a draw plate into parallelepipeds or cylinders 0.3-4.5 mm in diameter. The specimens were subsequently irradiated with a laser beam through quartz windows. The lifetime of such targets under $2 \cdot 10^{-5}$ torr is over 30 min long. Up to 10 such targets 6-7 mm long can be produced in four minutes. Figures 2; references 12: 1 Russian, 11 Western.

SPATIAL COHERENCE OF LIGHT WHICH HAS PASSED THROUGH LIGHT GUIDES

KUCHIKYAN, L. M. and SIDAK, P. I.

[Abstract] A study is presented of the degree of spatial coherence of laser
radiation which has passed through 2-layer fiber light guides as a function
of the length of the guides and the divergence of the radiation entering the
light guide. Young's method is used to measure the spatial coherence of gas
laser radiation and it is shown that the spatial coherence is determined by
the relationship between the time coherence of the source and the time delay
between rays propagating in the light guide at different angles. If the time
coherence of the source is much greater than the time delay between rays, the
degree of spatial coherence of the radiation passing through the light guide
is practically unchanged. Experimental results are produced which confirm
these theoretical conclusions. This work indicates that short light guides
with diameter large in comparison to wavelength practically cause no
deterioration in spatial coherence of the radiation if time coherence is
high. Figures 4; references 15: 10 Russian, 5 Western.

CHANGE IN THE SPECTRUM OF A NEON SUPERRADIATION PULSE UPON INTERACTION WITH
A RESONANTLY ABSORBING PLASMA IN THE POSITIVE COLUMN OF A GLOW DISCHARGE

YEGOROV, V. S., ZATSERKOVNYUK, N. M. and VOL'FOVSKIY, I. G.

[Abstract] Continuing earlier studies of the effect of strong nonlinear
absorption upon interaction of a short Ne superradiation pulse with reso-
nantly absorbing metastable Ne atoms produced by a powerful pulsed discharge
in an He-Ne mixture, in which the clarification of the optically dense medium
was explained as a possible result of self-induced transparency, the authors
study the spectral composition of the superradiation line by means of a
Fabry-Perot interferometer. It is found that the maximum of the superradiation
line of Ne is shifted from 614.3 nm into the longer wave area. The degree of
shift depends on the pressure in the laser tube and the power of lasing. The
maximum shift was 160 MHz at 4.7 mm Hg. The nature of the shift is not clear.
Strong nonlinear absorption of a short pulse of coherent light, accompanied
by changes in the spectrum of the pulse, depending in a complex manner on its
characteristics at the input to the absorbing system, is observed. The
experimental results can be qualitatively understood from the standpoint

of nonlinear coherent interaction between the absorbing substance and the propagating superradiation pulse. The pulse length is much shorter than the time of phase memory in the medium. The changes in pulse spectrum may, therefore, be related to its amplitude and phase modulation which occurs in this process. Figures 2; references 10: 6 Russian, 4 Western.

INFLUENCE OF CONDITIONS OF EXCITATION ON RADIAL DISTRIBUTION OF POPULATION INVERSION IN THE ACTIVE ELEMENT OF A HELIUM-NEON LASER

LEONT'YEV, V. G. and OSTAPCHENKO, YE. P.

[Abstract] A study is made of the influence of various excitation conditions on the radial distribution of population inversion in the active element of a helium-neon laser with an inside diameter of 3 mm. The gain is calculated considering the balance equation for the population of levels in the steady state and experimental values of discharge plasma parameters. It is assumed that the population of the upper lasing level 3 s_2 results from direct electron collision and transfer of energy upon collisions of the second kind with helium atoms in the 2^1S state. The calculations show that the unsaturated gain of the helium-neon mixture along the axis of the tube is maximal with lower pressure and pumping current and higher ratio of helium pressure to neon pressure than it is at the periphery of the discharge channel. Consequently, these conditions are also optimal for maximization of axial modes over transverse modes. The authors thank S. D. Vagner for useful discussion and advice. Figures 3; references 35: 24 Russian, 11 Western.

FEASIBILITY OF USING PHOSPHOROSILICATE FIBER OPTICS IN THE NEAR-INFRARED RANGE

GODIK, E. E., GRIGOR'YANTS, V. V., DEMENTIENKO, V. V., IVANOV, G. A., KUZNETSOV, A. I., and SINIS, V. P., Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] Research on the use of fiber optics for the 0.8-1.1 µm range of wavelengths is now underway. A study was made to establish the feasibility

of using such fiber optics also for the 0.9-3 µm range of wavelengths. Gradiental phosphorosilicate fibers were tested for losses and attenuation over this range of the near infrared. Two translucence windows were found: the first one over the 1.05-1.25 µm range with only 10 dB/km attenuation (the absolute minimum 0.5 dB/km not being attainable here because of appreciable light scattering by macroinhomogeneities) and the second one over the 1.45-1.55 µm range with 50 dB/km attenuation. The steep increase of attenuation beyond 100 dB/km at wavelengths above 2 um could be due to increased light absorption by H-0 and P-0 bonds. A communication line with phosphorosilicate fiber optics operating at the 1.54 µm wavelength (in the second translucence window) was experimentally constructed and a signal to noise ratio of 10 dB found feasible over a distance of approximately 500 m. Figures 1; references 5: 2 Russian, 3 Western.

FUNCTIONAL COMPONENTS OF OPTICAL INTEGRATED CIRCUITS BASED ON EPITAXIAL GaAlAs-GaAs HETEROSTRUCTURES

BYKOVSKIY, YU. A., ZAKHAROV, YU. P., MAKOVKIN, A. V., MALYSHEV, V. K., MOLOCHEV, V. I., SMIRNOV, V. L., TALENSKIY, O. N., and SHMAL'KO, A. V., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow, Moscow Engineering Physics Institute

[Abstract] An analysis was made of active devices built on epitaxial GaAlAs-GaAs heterostructures with a common GaAs substrate, for use in integrated optics. A combination of a passive thin-film waveguide and an active twin heterostructure on the same substrate could be used for simulating almost all basic components of such optical integrated circuits. A diffraction grating was cut on the waveguide surface and a semiconductor laser with a distributed Bragg mirror operated in the pulse mode at room temperature, with a pulse width of 100-300 ns and a pulse repetition rate of 100-500 Hz. The results show that a half-wave voltage of approximately 40 V is attainable by optoelectronic modulation of the laser radiation in such a waveguide. Figures 2; references 11: 7 Russian, 4 Western.

LASER INTERFEROMETERS ON FIBER OPTICS

ALEKSEYEV, E. I., BAZAROV, YE. N., GRIGOR'YANTS, V. V., DETINICH, V. A.,
IVANOV, G. A., KORENEVA, N. A., SVERCHKOV, YE. I., TELEGIN, G. I., and
CHAMOROVSKIY, YU. K., Institute of Radioelectronics, USSR Academy of
Sciences, Moscow

[Abstract] Single-mode fiber optics for conducting coherent light signals
in laser interferometers have been produced by the vapor-gas deposition
process. The sheath layer approximately 75 μm in diameter was made of
pure SiO_2, the active strands 7-8 μm in diameter were made of SiO_2 doped
with phosphorus. Their radial profile of the refractive index could not
be measured directly. Instead, the wider strands (15 μm diameter) prior
to their reduction to size were used for these measurements. Typical
interference patterns in the near field and in the far field are shown.
Figures 3; references 3: 1 Russian, 2 Western.

A HIGH-LUMINOSITY X-RAY SPECTROGRAPH WITH VERTICAL FOCUSING FOR LASER PLASMA EXAMINATION

SHEVEL'KO, A. P., Physics Institute imeni P. N. Lebedev, USSR Academy of
Sciences, Moscow

[Abstract] An x-ray spectrograph with vertical focusing is described which
has been designed according to L. V. Hamos and whose excellent characteristics
make it very suitable for laser plasma examination. It combines a high
luminosity with a high spectral resolution and, moreover, it does not shield
the laser plasma from other instruments used in complex diagnostic tests.
The essential components are a curved 80x80x0.03 mm mica crystal and a
photographic film in a plane perpendicular to the spectrograph axis. Typical
plasma spectrograms are shown. Figures 3; references 10: 7 Russian,
2 German, 1 Western.

CONTROLLED TRANSPARENCIES ON MAGNETIC CRYSTALS

BALBASHOV, A. M., KOMLEV, A. A., MIKAELYAN, A. L., STOLYAROV, A. K., and CHERVONENKIS, A. YA.

[Abstract] A feasibility study was made concerning the use of controlled transparencies in optical information processing systems, particularly in holographic memories. On the basis of their optical characteristics, magnetic field structure, energy characteristics, and information carrying capacity, orthoferrite plates (single crystals cut normally to the optical axis) and bismuth-garnet epitaxial films were found to provide the desirable sharp contrast between "1" and "0" transmitted light intensities as well as fast response and a low power drain. Experimental specimens have been built with a capacity of 100x100 bits, a 350:1 contrast, a switching current below 1 A, a switching time within 10^{-6}-10^{-8}s, and an optical efficiency above 10%. The test results are compared with a theoretical performance analysis. Figures 9; tables 1; references 21: 10 Russian, 11 Western.

PHASE CONTROLLED TRANSPARENCIES IN COHERENT-LIGHT INSTRUMENTS REALIZING WALSE AND HILBERT TRANSFORMATIONS

VASIL'YEV, A. A., VASHURIN, P. V., and KOMPANETS, I.N., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Transparencies serve as space-time light modulators in processing of optical information and, at the same time, controlling the pulse response of optical instruments. A study was made to establish the feasibility of using phase controlled transparencies with an orientative S-effect for the realization of two-dimensional Walsh and Hilbert transformations. A matrix-type address system seemed most effective for operating with these binary functions with separable variables. Liquid crystals (23.3% p'-cyanophenyl) p-n-butylbenzoate + 30% p'-cyanophenyl p-n-hexylbenzoate + 46.7% p'-cyanophenyl p-n-heptylbenzoate) with a positive dielectric anisotropy $\Delta\varepsilon$= 23 and with the nematic phase existing at temperatures from 10 to 70°C. Figures 7; tables 1; references 11: 6 Russian, 1 German, 4 Western.

IMMERSED OPTICAL DIFFUSE WAVEGUIDES

ZOLOTOV, YE. M., KISELEV, V. A., PELEKHATYY, V. M., PROKHOROV, A. M.,
CHERNYKH, V. A., and SHCHERABAKOV, YE. A., Physics Institute imeni
P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Silver ions from a melt of $AgNO_3$ were diffused into a glass
substrate at 280°C for 1.5 h and the plates were subsequently annealed in
air at about the same temperature for 1.5 h. A 13-mode waveguide thus
produced was then immersed in a melt of $NaNO_3$ at 300°C for 20 min, resulting
in a 12-mode waveguide with the first two TE-modes strongly suppressed.
The thickness profiles of the refractive index were measured in both cases
and could be graphoanalytically approximated by merging a shifted parabola
with an exponential curve. The parameters of these profiles depend on the
immersion depth and can thus be adjusted so as to yield the maximum increment
of refractive index at a certain distance from the surface. This method of
profile identification was also used on a 4-mode immersed diffuse waveguide
in grade K8 glass. Figures 3; references 3: 1 Russian, 2 Western.

PROPAGATION OF NATURAL MODES THROUGH MULTILAYER OPTICAL WAVEGUIDES. PART 3: WAVEGUIDES WITH NEGATIVE WAVEGUIDE DISPERSION AND STRONG FILTRATION OF HIGHER-ORDER MODES

BELANOV, A. S. and DIANOV, YE. M., Physics Institute imeni P. N. Lebedev,
USSR Academy of Sciences, Moscow

[Abstract] A circular dielectric waveguide consisting of three layers with
five different combinations of refractive indices is analyzed. It features
a shell of optically less dense material between the inner core and the outer
shell, the refractive index of the latter being chosen arbitrarily but its
thickness sufficiently large so that the medium of the intermediate shell does
not significantly influence the characteristics of natural modes. From the
fundamental characteristic equation is now derived the dispersion character-
istic, with the normalized frequency expressed in terms of transverse wave
numbers. The results reveal a strong filtration of higher-order modes and
an effective transmission of maximally wideband pulses. The negative wave-
guide dispersion partly compensates the dispersion of the material. In
multimode operation of such a waveguide it is possible to propagate a pulse

two orders of magnitude wider than in a conventional multimode dielectric
waveguide. Figures 5; references 8: 6 Russian, 1 German, 1 Western.

ANHYDROXYLIC QUARTZ GLASS FOR LOW-LOSS FIBER OPTICS AND ITS COMPARATIVE
RADIATION-OPTICAL PROPERTIES

BOGANOV, A. G., DIANOV, YE. M., KORNIENKO, L. S., NIKITIN, YE. P., RUDENKO,
V. S., RYBALTOVSKIY, A. O., and CHERNOV, P. V., Physics Institute imeni
P. N. Lebedev, USSR Academy of Sciences, Moscow, Institute of Silicate
Chemistry imeni I. V. Grebenshchikov, USSR Academy of Sciences, Leningrad,
Scientific Research Institute of Nuclear Physics, Moscow State University
imeni M. V. Lomonosov

[Abstract] Completely "dry" quartz glasses ($[OH] \leq 1 \cdot 10^{-4} - 1 \cdot 10^{-5}$ wt.%)
containing neither measurable concentrations of chlorine nor any dissolved
gases can now be made only by fusion of pure amorphous or crystalline silica
under high vacuum. A new technological process of synthesizing extra-pure
anhydroxylic quartz glass consists of electrical fusion of very-pure
cristobalite powder under vacuum, such as powder having been produced by
a special supplementary high-temperature heat treatment of granular synthetic
extra-hyperpure silicon dioxide. Two batches of such a glass have been
analyzed for impurity content and their optical properties compared with
those of conventional anhydroxylic glass. Their characteristics are a
high degree of optical homogeneity, with only about 0.1 vol.% of defect
zones, and a high transmittivity, especially in the ultraviolet range and
with minimum induced luminescence at 396 or 280 nm wavelengths. As to the
effect of gamma radiation, electron-paramagnetic-resonance measurements
indicate that these special-grade glasses are less resistant than alkali-
silicate grades to small doses ($10^4 - 10^5$ R) but about as resistant to large
doses (10^8 R). This limited radiation resistance of the special grades is
attributed to the presence of modifier ions in the lattice. Figures 6;
tables 3; references 12: 3 Russian, 9 Western.

USSR

EVOLUTIONARY CHANGE IN THE REFRACTION CHARACTERISTICS OF A GAS DUE TO STIMULATED
RAMAN SCATTERING OF LIGHT

BAKLUSHINA, M. I., ZEL'DOVICH, B. YA., MEL'NIKOV, N. A., PILIPETSKIY, N. F.,
RAYZER, YU. P., SUDARKIN, A. N., and SHKUNOV, V. V., Institute of Problems
in Mechanics at the USSR Academy of Sciences

[Abstract] Passage of a sufficiently strong light beam through a molecular
medium results in stimulated Raman scattering. The oscillatory excitation
of many molecules, in turn, affects the refractive index along the light path
and causes refraction of the transmitted radiation. The focusing effect is
due to a higher polarizability of excited molecules and a larger refractive
index along the light path. A study was made to determine the effect of
changes in not only the angular characteristics of a light beam but also in
the refraction characteristics of the medium along that beam. Measurements
were made by holographic interferometry in hydrogen under a pressure of 10 atm.
A theoretical evaluation of the interferograms yields the increment of
polarizability, the concentration of excited molecules, the heating of the
gas, and the resulting thermal defocusing of stimulated Raman scattering,
as functions of time. The critical period of the thermal expansion process
was the time during which sound travels the characteristic length of the
radius of the gas column where heat release occurs. On the basis of the
results, including patterns of diverging and converging light waves, an
equivalent lens is designed which yields the same focusing and defocusing
effects. Figures 3; references 17: 12 Russian, 5 Western.

APPARATUS FOR A COMPOSITE THERMOPHYSICAL STUDY OF LIQUIDS IN THE SUPER-CRITICAL STATE UNDER CONDITIONS OF MONOTONIC HEATING

MUSTAFAYEV, R. A., Azerbaydzhan Polytechnic Institute, Baku

[Abstract] For determining the thermophysical properties of a large class of organic liquids in the supercritical state, it has become necessary to consider the nonlinear theory of thermal processes and thus take into account the temperature dependence of the thermal conductivity (λ) and the specific heat (c_p). Accordingly, a dynamic composite c,λ-calorimeter consisting of two vessels is proposed here with which measurements can be made by the method of monotonic heating over a wide range of temperature and pressures. With it are furnished: a system for monostaticizing with special valves for feeding the test substance, two sets of thermocouples with a potentiometer and a commutator, and two heater coils receiving power through an autotransformer. A mercury-type separator controlling the liquid levels operates on the principle of connected vessels. This apparatus has been successfully used for measuring the thermal conductivity and the specific heat of n-hendecane and n-tridecane at temperatures from 34.6 to 404.5°C under pressures from 1 to 500 kgf/cm^2. Figures 4; tables 2; references 16: 15 Russian, 1 Western.

HEATING AND SUBLIMATION OF SOOT PARTICLES IN A FLAME UNDER LASER RADIATION

BURAKOV, V. S., KONDRASHOV, N. G., STAVROV, A. A., and ZAKHAROVA, I. S., Institute of Physics, Academy of Sciences of the Belorussian SSR, Minsk

[Abstract] Heating and sublimation of soot particles under monochromatic laser radiation are analyzed in terms of transient heat conduction and evaporation kinetics in a condensate. Soot is regarded as a monodisperse porous medium with a concentration of particles about $2 \cdot 10^{18}$ m^{-3}, their most probable diameter about 18 nm and no interaction between them occurring. The thermal conductivity as well as the specific heat and the heat of evaporation are approximated as piecewise linear functions of the temperature. The heat transfer coefficient and the absorption coefficient are also taken into account in solving this boundary-value problem. The analytic solution has been evaluated numerically in a computer experiment and the results compared with actual test data. Figures 4; references 25: 20 Russian, 5 Western.

GLASS FIBER OPTICS WITH LOSSES BELOW 1 dB/km

BELOV, A. V., GUR'YANOV, A. N., DEVYATYKH, G. G., DIANOV, YE. M.,
NEUSTRUYEV, V. B., NIKOLAYCHIK, A. V., PROKHOROV, A. M., KHOPIN, V. F.,
and YUSHIN, A. S., Physics Institute imeni P. N. Lebedev, USSR Academy
of Sciences, Moscow Institute of Chemistry, USSR Academy of Sciences, Moscow

[Abstract] A report is presented on the development of glass fiber optics
with a SiO_2 + GeO_2 core and a SiO_2 shealth. These fibers are intended for the
0.8-1.1 um range of wavelengths, with total losses near the absolute minimum.
Specimens were produced by chemical deposition from the gaseous phase at
about 1500°C and plasma sputtering at about 1800°C. It took one hour of
processing time to produce an ingot 120 m long and 7 mm in diameter, from
which an about 400 m long conductor (120 um outside diameter and 40 um core
diameter) was drawn. Various batches with different hydroxyl contents in
the core glass were tested for attenuation characteristics and profiles
of the refractive index. The absolute minimum attenuation near 0.5 dB/km
was found to fall within the 1.1-1.7 um range of wavelengths. The dis-
persion of the material, a factor limiting the parameters of the trans-
lucence window, was in quartz glass found to decrease with increasing
wavelength to near zero within this 1.1-1.7 um range. Other advantageous
features of these glass fibers are their high radiation resistance and the
larger core diameter required for single-mode transmission. Figures 2;
references 10: 3 Russian, 7 Western.

OPTICAL HETERODYNING ON THE BASIS OF COLLINEAR OPTOACOUSTIC INTERACTION IN
TRIGONAL CRYSTALS

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[Abstract] An experimental study was made to determine the feasibility of
optical heterodyning on the basis of the collinear optoacoustic effect, i.e.,
collinear light scattering by elastic waves in α-SiO_2, α-Al_2O_3, and $LiNbO_3$
crystals. The theoretical analysis of this effect is based on the laws of
energy and momentum conservation. The test apparatus consisted of two
polaroids, two oscillographs, a photoreceiver, an rf oscillator, a pulse
generator, an amplifier, and a power supply. The optoacoustic interaction
was measured over the 80-1000 MHz frequency range with light at the wavelength
λ = 0.6328 μm. The results indicate the applicability of this heterodyning
method to optical data processing and to laser interferometry. Figures 8;
references 9: 2 Russian, 7 Western.

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